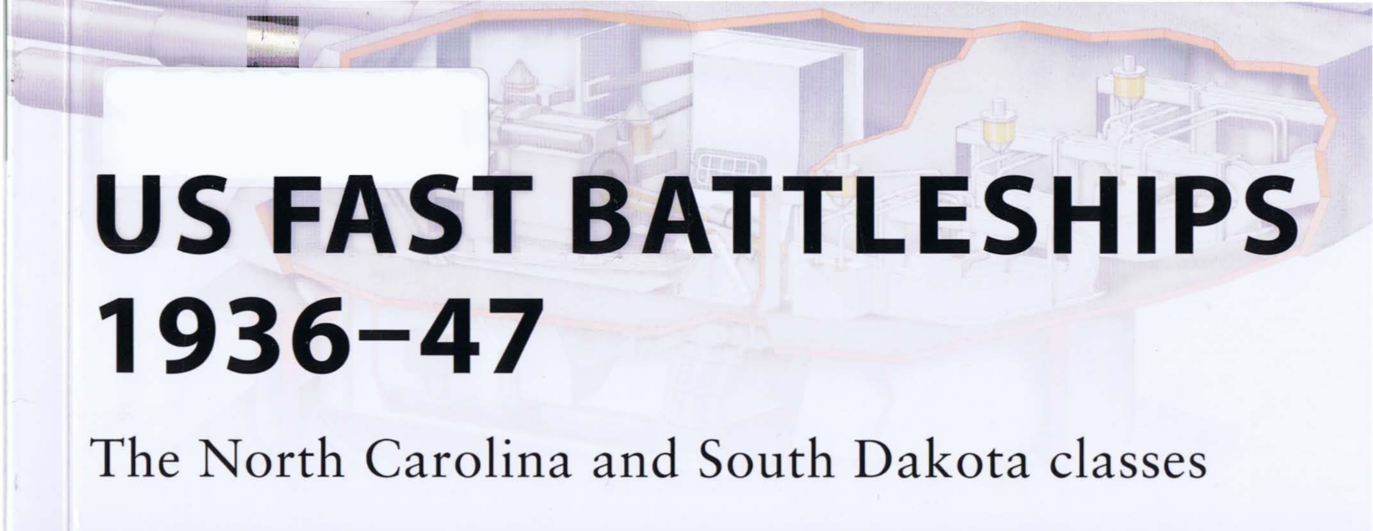
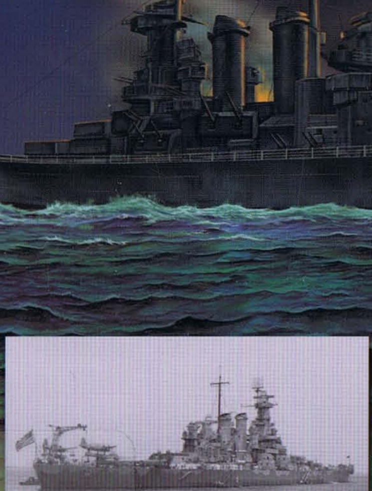


US FAST BATTLESHIPS 1936–47

The North Carolina and South Dakota classes



LAWRENCE BURR

ILLUSTRATED BY PETER BULL

ABOUT THE AUTHOR AND ILLUSTRATOR

LAWRENCE BURR has had a lifelong passion for naval history. He was recently the British specialist on a Channel 4 documentary about the battle of Jutland. He has also been part of a team who has conducted underwater explorations of the Battlecruiser wrecks and has visited a number of the key battleships detailed in this volume. He lives in the USA.

PETER BULL graduated from art college in 1979 and has worked as a freelance illustrator for over 25 years. He has created both traditional and digital art for publishers worldwide, and also runs the Peter Bull Art Studio, based in Kent, UK, which he founded in 1975.

NEW VANGUARD • 169

US FAST BATTLESHIPS 1936–47

The North Carolina and South Dakota classes

LAWRENCE BURR

ILLUSTRATED BY PETER BULL

First published in Great Britain in 2010 by Osprey Publishing,
Midland House, West Way, Botley, Oxford, OX2 0PH, UK
44-02 23rd St, Suite 219, Long Island City, NY 11101, USA

© 2010 Osprey Publishing Ltd.

All rights reserved. Apart from any fair dealing for the purpose of private study, research, criticism or review, as permitted under the Copyright, Designs and Patents Act, 1988, no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, electrical, chemical, mechanical, optical, photocopying, recording or otherwise, without the prior written permission of the copyright owner. Inquiries should be addressed to the Publishers.

A CIP catalog record for this book is available from the British Library

ISBN: 978 1 84603 510 4
E-book ISBN: 978 1 84908 292 1

Page layout by: Melissa Orrom Swan, Oxford
Index by Mike Parkin
Typeset in Sabon and Myriad Pro
Originated by PPS Grasmere Ltd, Leeds, UK
Printed in China through World Print Ltd.

10 11 12 13 14 10 9 8 7 6 5 4 3 2 1

Osprey Publishing is supporting the Woodland Trust, the UK's leading woodland conservation charity by funding the dedication of trees.

www.ospreypublishing.com

AUTHOR'S ACKNOWLEDGMENTS

The author wishes to acknowledge the help and assistance of the following: Captain Ben W. Blee, USN (Ret); Jeffrey Nilsson, Executive Director, Historical Naval Ships Association; Kim Sincox, Museum Services Director, and Mary Ames Booker, Curator of Collections, Battleship *North Carolina*; Bill Tunnell, Executive Director, and Lee Bryars, Crew Chief, Museum USS *Alabama*; Mark Hayes, Naval Historical Center; Professor Douglas V. Smith, Naval War College; Captain Christopher Page (RN) Ret, and Dr Malcolm Llewellyn-Jones, Historian, Naval Historical Branch; Ron Kurpiers, researcher; and my wonderful wife Judi, whose patience and humor helped me cope with a new computer.

PHOTOGRAPHIC CREDITS

All the photographs printed in this book are by: Courtesy Battleship *North Carolina*.

CONTENTS

INTRODUCTION 4

THE WASHINGTON NAVAL TREATY – 1922 4

DESIGN AND CONSTRUCTION 7
- The North Carolina class
- The South Dakota class
- Fire control
- Radar
- Aircraft

FAST BATTLESHIP OPERATIONS 15
- The Atlantic
- The Pacific

CONCLUSION 42

BIBLIOGRAPHY 44
- Books
- Internet

APPENDICES 45
- South Dakota class
- North Carolina class

INDEX 48

US FAST BATTLESHIPS 1936–47

THE NORTH CAROLINA AND SOUTH DAKOTA CLASSES

INTRODUCTION

The six battleships of the North Carolina and South Dakota classes, built between 1937 and 1942, represented a dramatic development from the pre-1922 battleships of the US Navy. The Washington Naval Treaty (WNT) of 1922 and the resulting battleship-building "holiday" stopped the gradual development process of battleship design that had flowed from the launching of the British HMS *Dreadnought* in 1905. In 1937, US Navy designers had to set a design within three fixed parameters: the width of the Panama Canal, a maximum displacement of 35,000 tons, and a maximum main armament caliber of 16 inches. The designed speed of 27 knots for these six battleships was set on the basis of faulty intelligence of the speed of the Japanese Kongo class of fast battleships of 26 knots.

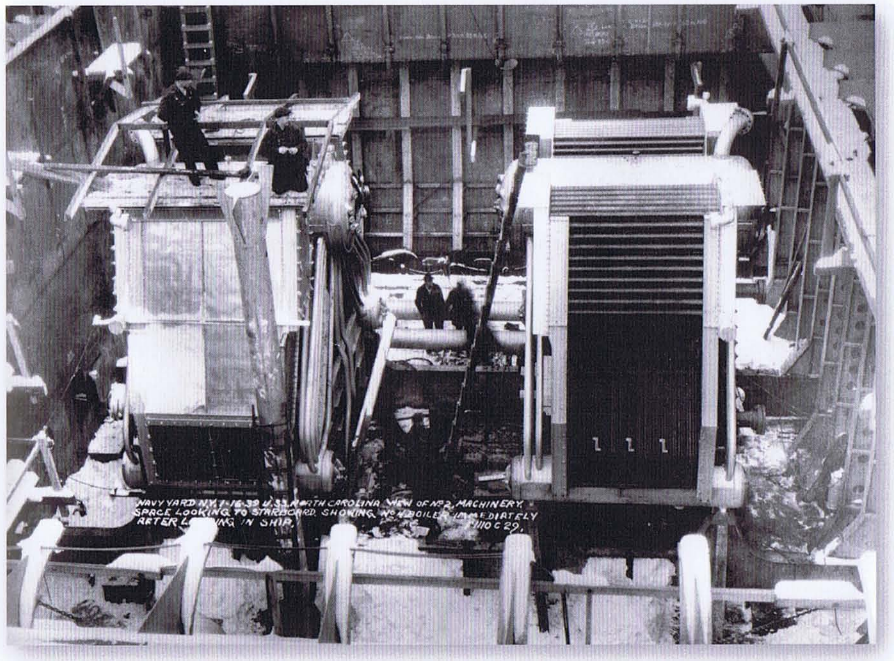
The design of the North Carolina and South Dakota class battleships was very successful. Although their service life was relatively short (all six fast battleships were decommissioned in 1947), they undertook a multiplicity of roles in both the Atlantic and Pacific theaters of war, and helped forge a new war-winning weapon system. This book tells the story of how these ships came into being and how they were used in World War II.

THE WASHINGTON NAVAL TREATY – 1922

> *"The United States of America, the British Empire, France, Italy and Japan: Desiring to contribute to the maintenance of the general peace, and to reduce the burden of competition in armament;"*
> Introduction to the Washington Naval Treaty, signed on February 6, 1922.

The purpose of the WNT was to curtail the developing naval race between the US, Great Britain, and Japan, and thereby allow the US, and Great Britain in particular, to recover financially from World War I. The cost of new fleets of battleships was seen as politically and financially prohibitive in a war-weary environment at the conclusion of the "War to end all Wars."

The signed treaty limited the construction of new battleships, defined as armored ships in excess of 10,000 tons, until December 1931. The subsequent London Naval Treaty of 1930 extended this limitation until 1936. Additionally, the WNT limited the number of battleships for each country by establishing a total maximum standard displacement of 525,000 tons each for the US and Great Britain, 315,000 tons for Japan and 175,000 tons each for France and Italy. This was referred to as the 5-5-3-1.75-1.75 ratio. To bring the terms of the treaty into being, the US and Japan were authorized to complete two new battleships under construction. The UK was authorized to build two new battleships but their displacement was limited to 35,000 tons and their main armament caliber to 16 inches.


NAVY YARD N.Y. 1-16-39 U.S.S. NORTH CAROLINA VIEW OF No 2, MACHINERY.
SPACE LOOKING TO STARBOARD. SHOWING No 4 BOILER IMMEDIATELY
AFTER L NG IN SHIP.
1110 C 29.

Babcock and Wilcox high-pressure boilers being installed in *North Carolina*'s No. 2 machinery space.

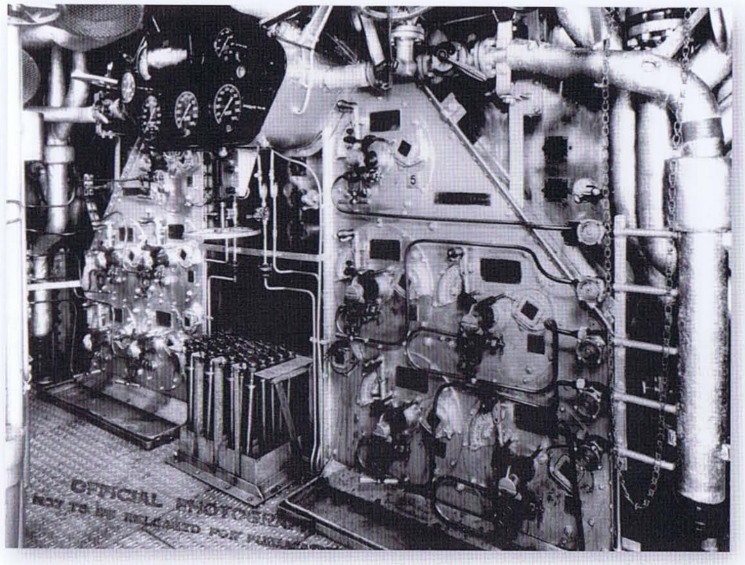
An immediate consequence of this treaty was the scrapping of battleships under construction and in operation to achieve the agreed ratios. For the US, it resulted in the scrapping of 15 battleships and the cancellation of 15 under construction. This left the US Navy with 18 battleships, including the two to be completed in accordance with the treaty. Additionally, two battlecruisers under construction were to be converted to aircraft carriers.

Existing battleships could be modernized to increase defense against air and submarine attack by adding side blisters and additional horizontal deck armor to a limit of 3,000 tons per ship. The sinking of *Ostfriesland*, *Virginia*, and *New Jersey* in 1921 in bombing trials led by Billy Mitchell pointed to the growing risk to battleships from aircraft.

The treaty also limited the number of aircraft carriers to a total displacement to 135,000 tons for the US and UK, 81,000 tons for Japan, and 60,000 tons each for France and Italy. The maximum displacement for each ship was 27,000 tons, with a proviso that the two US aircraft carriers, being converted from battlecruiser hulls, could be built up to 33,000 tons. All aircraft carriers in existence or being built on November 12, 1921 were considered experimental and could be replaced within the total tonnage limit. Main gun armament was limited to a caliber of 8 inches.

The treaty limitations established a maximum size for cruisers at 10,000 tons and 8-inch guns. As there was no limit placed on the number that could be built, the building of heavy cruisers became, in effect, a new naval race.

For the US Navy, the WNT achieved naval parity with the Royal Navy, then the preeminent naval power, without a costly naval building program and naval conflict (an approach with which Germany had failed). Following the treaty, Admiral Scheer, who had commanded the German High



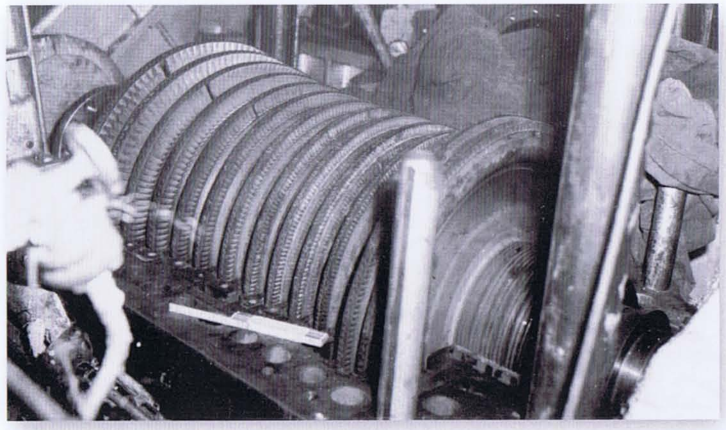
The operating face of the high-pressure boilers, showing left and right furnaces.

Seas Fleet in 1916, perceptively commented that the US Navy was the real victor of the 1916 battle of Jutland between the Royal Navy and the German Imperial Navy. Additionally, the treaty ended the Anglo-Japanese Naval Treaty of 1902, and the potential alliance of the Royal Navy with the Imperial Japanese Navy (IJN) against the US Navy in the Pacific. This was significant to the US, as war scares with Japan in the early 1900s had resulted in the Naval War College (NWC) creating a War Plan "Orange" to identify the major issues and required strategy for a naval campaign against Japan. The passage of the Great White Fleet across the Pacific in 1907 was an exercise to help identify the issues involved in a trans-Pacific voyage by the fleet, as well as showing the Japanese US naval strength.

Japan had not been successful in obtaining equal status with the US and UK in terms of total battleship displacement. In seeking to have naval dominance in the western Pacific Japan negotiated and achieved a "Non-Fortification Clause" that prevented naval bases in the Pacific from being developed and defended. For the US, this meant Guam, Wake, the Philippines, and the Aleutian Islands. The consequences of the "Non-Fortification Clause" gave the IJN a significant advantage in the event of hostilities with the US. The US Navy Fleet would have to pass through the Japanese mandate possessions of the Marshal, Caroline, and Mariana Islands to reinforce its fleet in the Philippines, Wake, and Guam. This would expose the US Fleet to interception and attrition tactics by the IJN, prior to an expected fleet battle. Additionally, the US Navy would have to retain ships in the Atlantic at the same time it commenced hostilities against Japan, with the result that the IJN would have an equal or larger fleet at the time of battle. The "Non-Fortification Clause" played a major role in driving the development programs of the US Navy.

The modernization program for pre-1922 battleships focused on converting coal-fired ships to oil-burning ships, enhancing fuel-storage for greater operating range, improving fire-control systems, modifying gun turrets to increase gun elevation and range, and air-borne gun spotting. The designing and building of heavy cruisers that could operate across the distances of the Pacific led to advances in marine engineering for increased power and speed with less weight.

The US Navy also commenced developing its air arm in terms of aircraft carriers, deck-loads, aircraft types and air/naval battle tactics, including the introduction of dive-bombing. Aircraft carriers were seen as mobile airfields in the absence of Pacific bases, providing air cover for the advancing fleet. The US Marines developed an amphibious doctrine for opposed landings reflecting the need of the US Navy to capture and hold Pacific islands. Additionally, the US Navy developed a logistical fleet train capability, including a floating dry-dock to supply and repair warships as they crossed



General Electric high-pressure impulse turbine showing 12 rotary blades.

the Pacific. Annual fleet exercises, referred to as "Fleet Problems," explored the strategic and tactical issues of a trans-Pacific campaign.

While Japan felt compelled to sign the WNT, a powerful clique within the IJN led by Admiral Kato Kanji believed that Japan warranted equal ranking in terms of the size of its battleship navy in relation to the US and Great Britain. This issue and the political power of the clique grew in significance and finally resulted in Japan giving notice in 1934 of its intention to withdraw from the naval treaty system during the Second London Naval Conference beginning in January 1936.

Ironically, the US Congress had prevented the US Navy from building to WNT tonnage standards until the Vinson-Trammell Act of March 1934. This Act authorized and funded the construction of 102 ships over an eight-year period to bring the US Navy up to its WNT limits.

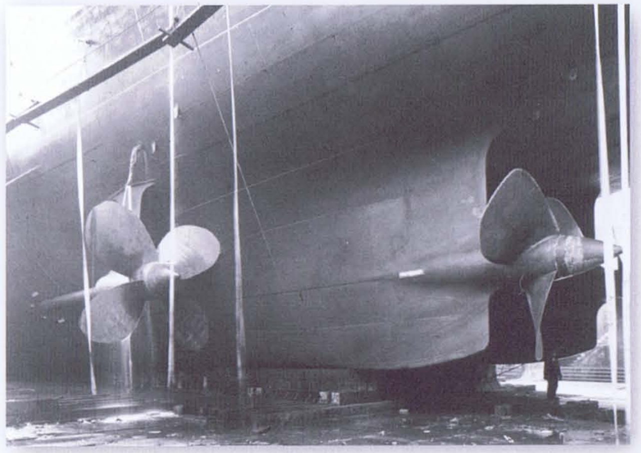
The battleship-building holiday that lasted from 1923 until 1937 for the US Navy resulted in a dramatic change in battleship characteristics with the laying down of the new fast battleships.

DESIGN AND CONSTRUCTION

The North Carolina class

The North Carolina class battleships were the first battleships to be built in the US since the USS *West Virginia* was commissioned on December 1, 1923.

The process that led to the final design for the North Carolina class battleships had commenced in 1928, in anticipation of the WNT ending in December 1931. The extension of the building holiday clause of the WNT by the London Naval Treaty in 1930 to December 1936 took away the necessity for the design plans to be finalized. However, two critical design characteristics emerged from the 1928 design process: the 5-inch/38 caliber high-angle dual-purpose gun for secondary armament, and an evaluation of the 16-inch/50 caliber and 45 caliber main armament.



Aft view of port propellers and both skegs. The inner skeged propellers have three blades. These propellers were changed to five blades to overcome vibration problems at high speeds. Note the man standing between the skegs.

In 1931 the General Board of the US Navy, responsible for setting the basic design parameters for US warships, required an evaluation of a potential small battleship design of less than 35,000 tons armed with 12-inch guns. This small battleship concept had been suggested by the Admiralty of the Royal Navy for discussion at the next naval treaty conference planned for 1936. However, the concept was considered unacceptable to the US Navy in light of battleships, battlecruisers, and pocket battleships in service with the Royal Navy, IJN and the new German Navy, and under construction in France and Italy.

Interestingly, in 1933, the design process generated a hybrid fast battleship/aircraft carrier. The purpose of this hybrid ship was to escort and protect fast fleet carriers, with its triple armament of 12-inch or 14-inch guns, a large number of anti-aircraft (AA) guns and eight aircraft carried below deck. The displacement was suggested between 19,500 and 28,500 tons with a speed of 32.5 knots. This hybrid concept did not survive the detailed design process that commenced in 1934 and focused on the key differences between slow battleships at 21 knots and fast battleships with a speed of 30 knots.

A key consideration in this process was the assumed speed of the IJN's Kongo class of fast battleships, the *Kongo*, *Haruna*, *Hiei*, and *Kirishima*, which had been modernized following the WNT with increased armor protection from their original battlecruiser design. The speed was assumed to be 26 knots, but these ships were in fact much faster, a fact unknown to the US Navy in 1934. However, even the assumed speed of 26 knots made the Kongo class 5 knots faster than existing US battleships.

The General Board saw the need for a battleship built to treaty limits that would act as a "fast-wing" of the US battle fleet to catch the Kongo class fast battleships, as well as having the speed and endurance to hunt down and destroy the commerce raiders of Germany and Italy. This melding of battleship and Admiral Fisher's original battlecruiser concept roles established the need for and the role of a fast battleship.

General Board member Admiral Reeves argued in 1936 that the new battleships should have the same top speed, 33 knots, as fleet carriers. Admiral Reeves had driven the development of US carriers, and as captain of USS *Saratoga* during Fleet Problem IX in 1929 demonstrated the potential role of fleet carriers as Fast Task Force attack groups, operating independently of the main battle fleet. In effect this confirmed the potential as originally demonstrated by HMS *Furious* and the 1st Light Cruiser squadron in July 1918, when HMS *Furious* launched the first carrier strike of seven Sopwith Camel biplanes and destroyed German Zeppelins and their hanger base at Tondern.

However, during the period 1936/7, the final consideration for the design for the North Carolina class battleships focused on main armament and armor, with speed a secondary consideration. The WNT displacement clause

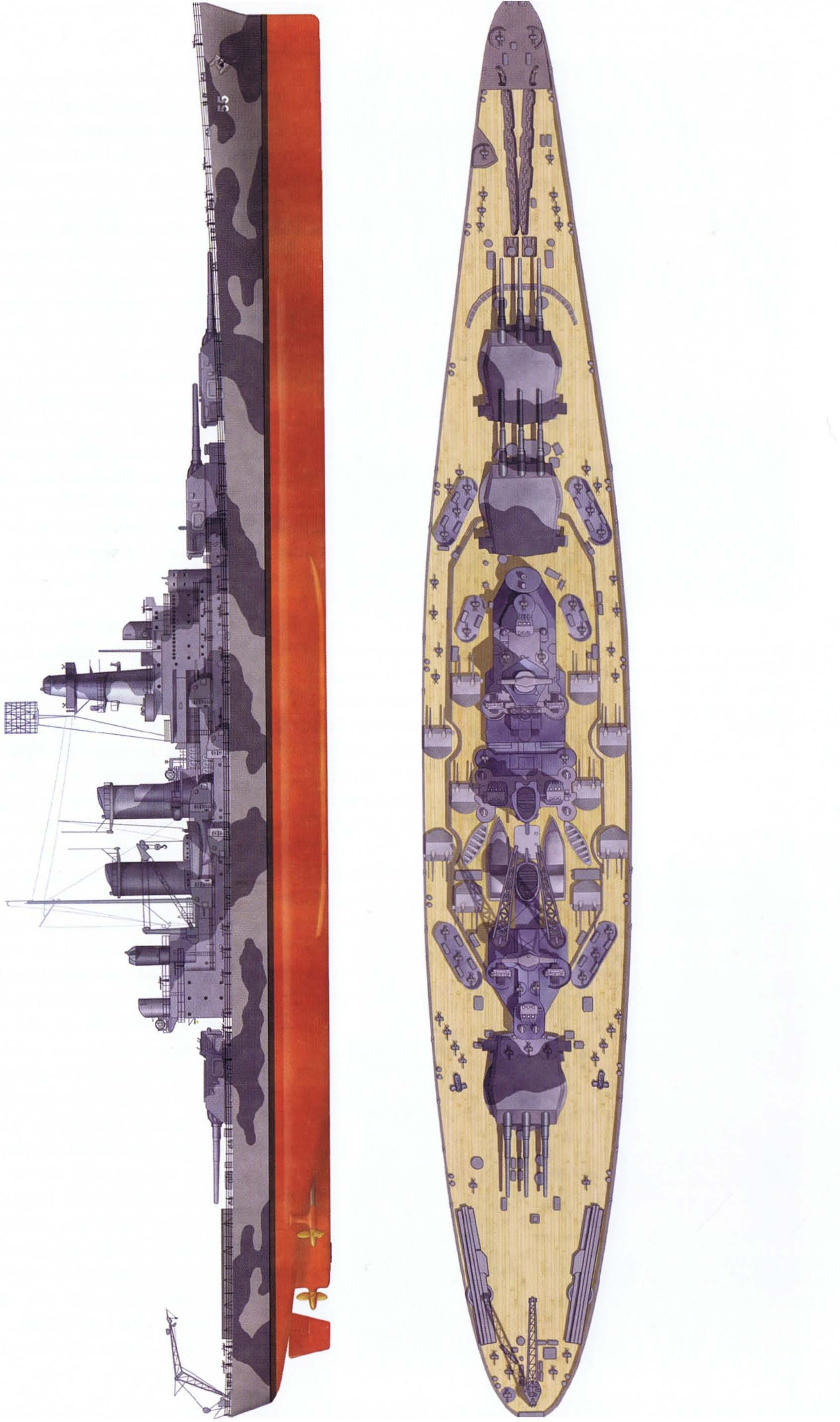
A

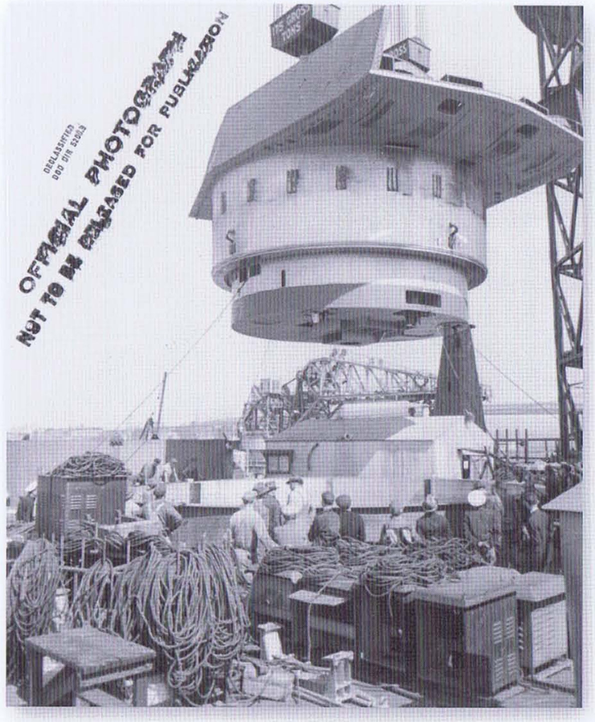
USS *NORTH CAROLINA*

The clean lines of *North Carolina*'s sweeping weather deck, and the tower superstructure topped with the massive CXAM "bedspring" radar, can be readily appreciated from the drawing of *North Carolina* as she appeared in early 1942. Her revolutionary and graceful design, with the secondary armament of 20 5-inch guns mounted in ten gun turrets, rather than in casements as in pre-1922 battleships, clearly marked her as a modern battleship in a period of increasing threat from aircraft.

This drawing of *North Carolina* depicts her as she was prior to the battle of the Eastern Solomons with 1.1-inch AA canons as the primary close-in weapon, and before "Stryker's Bridge" had been added. The battle of the Eastern Solomons showed that the AA armament was inadequate to prevent attacking aircraft from releasing either bomb or torpedo, but able to down the aircraft after the release when it was pulling out from its attacking maneuver and close in to the ship. This fact, together with the mechanical problems with the 1.1-inch canon, led to the adoption of the 40mm Bofors gun as the primary close-in AA gun that could destroy an attacking aircraft before it could release its weapon.

With four propellers and twin rudders, the *North Carolina* was very maneuverable, and able to match the gyrations of carriers as they maneuvered either to fly off and land aircraft or to dodge bombs and torpedoes. Although the first of the fast battleships, she was not fast enough to keep station with a carrier traveling at top speed of 33 knots.





The upper rotating gun house for Turret 3 being lowered into position by the 350-ton hammerhead crane at Brooklyn Navy Yard.

of 35,000 tons and the maximum beam that could be accommodated in the Panama Canal were the primary considerations for the designers. This led to the North Carolina class battleships having 15-degree inclined armor, four sets of lightweight geared turbines, and high-temperature high-pressure boilers, both of which were new technology. Turbines and boilers, with their respective supporting machinery, were combined in four machinery rooms rather than in separate engine and boiler rooms to provide greater survivability in the case of a torpedo hit. Between the inclined armor belt and the external hull plates were a series of watertight spaces that provided protection against torpedo blast and carried fuel and water. Together with the spaces created by the double bottom, the ships had 1.8 million gallons, or 7,167 tons, of fuel capacity for a 16,000-mile cruising range.

The balance between guns and armor originally established 12 14-inch guns in four turrets as the main armament. Secondary armament was 20 5-inch/38 guns in ten turrets. Armor protection was set to withstand hits from 14-inch guns, with an immune zone between 19,000 and 30,000 yards. The armored section of the ship extended from just forward of Turret 1 to just aft of Turret 3, thereby encompassing the magazines and machinery spaces. Finally, speed was set at 27 knots, sufficient to catch the assumed 26-knot speed of the Kongos but 6 knots slower than US fast carriers.

The Second London Naval Treaty of 1936 introduced escalator clauses to provide flexibility for signing nations, to counter the withdrawal of Japan from the naval treaty system and new battleships that Japan might build. The escalator clause covered displacement and the caliber for the main armament.

In July 1937, the Secretary of the Navy approved changing the main armament for the North Carolina class battleships from 12 14-inch to nine 16-inch/45 guns. This change was possible because the turret size for quadruple 14-inch guns was the same for triple 16-inch guns. In US Navy terms the ship was now unbalanced, in that the striking force of its guns was greater than the defensive capability of its own armor. But increases in armor protection would have increased displacement above the 35,000-ton treaty limit, and this was unacceptable.

OFFICIAL PHOTOGRAPH
NOT TO BE RELEASED FOR PUBLICATION

Lowering a 16-inch, 45 caliber gun into the right gun house in Turret 2.

The USS *North Carolina* was built at the New York Navy Yard, launched in June 1940, and commissioned in April 1941. The USS *Washington* was built at the Philadelphia Navy Yard, launched in June 1940, and commissioned in May 1941. Both ships experienced significant vibration along their propeller shafts and gearing and turbine machinery and the extent of this vibration adversely effected fire-control instruments. The cause of the vibration was traced to alternating thrusts emanating from inboard and outboard propellers resonating against the lightweight hull and machinery. Efforts to identify and then resolve the vibration led to the *North Carolina* sailing from and returning to the New York Navy Yard so many times that she gained the nickname "The Showboat." The problem was managed by changing the inner skeged propellers from three blades to five blades. Additionally, bracing was added to machinery. Both ships were then able to attain designed top speed at full power.

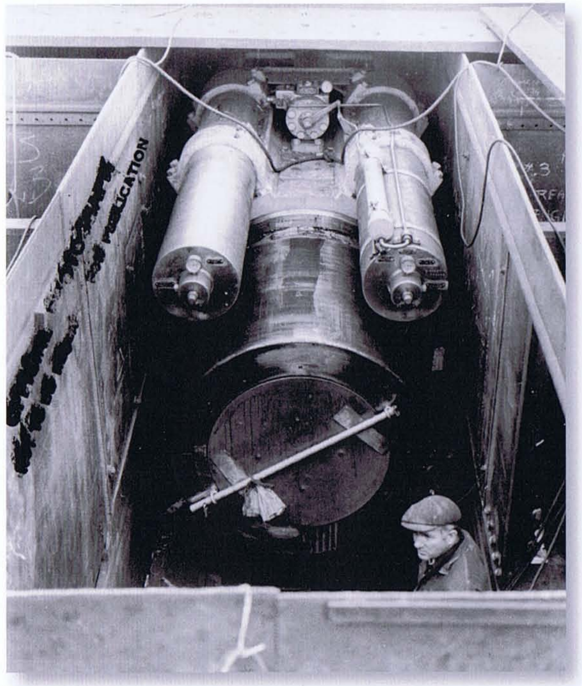
The two new "fast battleships" were very impressive, with their unbroken sweeping weather deck, pyramid tower superstructure, heavy main armament, turreted secondary armament, relatively high speed, and extensive cruising range.

The South Dakota class

Design of the South Dakota class commenced in 1937, and sought to rectify the inadequate armor design of the North Carolina class. But increasing the weight of armor and inclining side armor at 19 degrees to counter the steeper diving angle of 16-inch shells, whilst maintaining nine 16-inch guns, required significant weight savings in other areas of the ship in order to stay within the 35,000-ton limit. Additionally, these new ships were to serve as fleet and division flagships, requiring working and accommodation space for admirals and their staff.

Towards the end of designing the North Carolina class the possibility of ships sustaining underwater hull damage from steeply diving heavy shells that fell short of the ship was considered to be important. However, as the design process was so advanced, only supplemental protection for the magazines could be added. For the South Dakota class the danger from underwater shell hits was addressed and incorporated into the design to protect both magazine and machinery spaces. The inward sloping main armor belt from the armored deck was continued down to the inner bottom plates. Additionally, the strength of plates used for the outer and inner bottom plates and other internal longitudinal plates was increased relative to the North Carolina class.

A 16-inch, 45 caliber gun being installed. The two hydraulic recoil/run-out cylinders are clearly shown on the top of the gun.



In achieving the additional armor required to protect against 16-inch shells, the designers proposed a ship design of 666ft at the waterline, 47ft shorter than the North Carolina class at 713ft, in order to meet the 35,000-ton limit. As ship length equates to ship speed, the South Dakota class required increased engine power to achieve the same top speed of 27 knots as the North Carolina class. Incorporating increased engine power in a shorter hull required positioning sets of evaporators and distilling equipment into the four machinery rooms, along with the boilers and turbines, rather than into their own separate compartments. The boilers within the machinery spaces were raised one deck in order for the propeller shaft to run beneath them and thereby reduce the space required for machinery. Additionally, the bottom hull aft of the stern magazine was drastically reduced to, in turn, reduce hull drag. The two outer propellers and shafts were incorporated in skegs, creating a tunnel in which the inner two propellers were located, providing a measure of protection from torpedoes for the inner propellers.

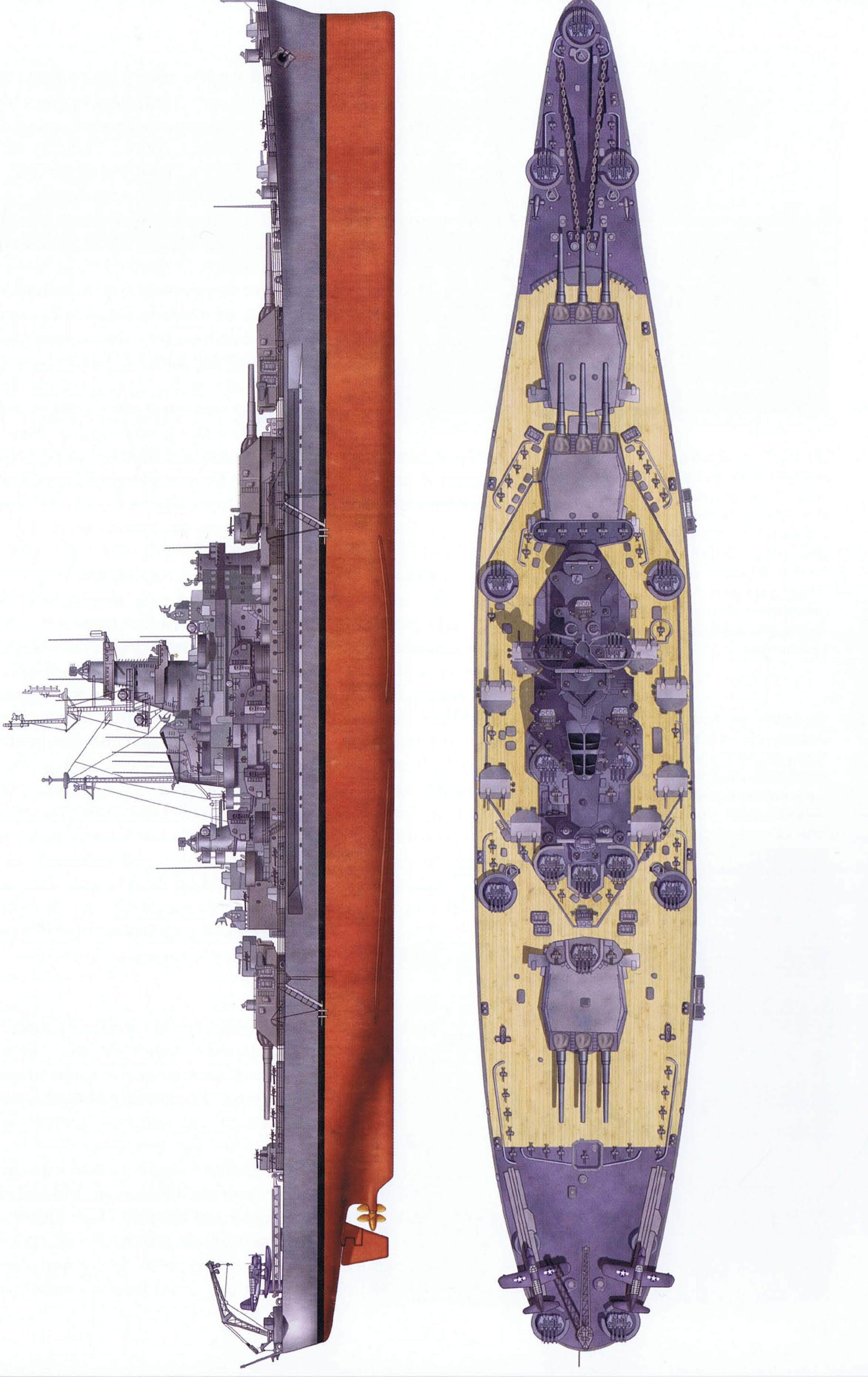
The shortened design incorporated a single funnel into the aft section of the superstructure. *South Dakota* was fitted with eight secondary 5-inch gun turrets rather than ten, and the space for the 5-inch handling room and magazine was used to provide accommodation. The USS *Indiana*, *Massachusetts*, and *Alabama* were built with 20 5-inch/38 guns in ten turrets.

The massive bridge and conning tower, incorporating the captain's command bridge with the admiral's bridge above and main battery fire control at top level followed aft by the superstructure tower and incorporated funnel, above a sweeping weather deck, gave the class a powerful appearance. The improved armor protection made the South Dakota class a more powerful battleship in battleship-vs-battleship action than the North Carolina class.

Fire control

Whilst guns, armor, and speed are essential characteristics of battleships, the ability to hit the target with their gunfire represents the ultimate justification for the time and money spent on developing and operating them.

The North Carolina and South Dakota class battleships were all fitted with Ford Instrument Mark 8 Range Keepers. These mechanical/electric fire-control analog computers were the latest development starting with the Stadimeter, invented by Lieutenant Fiske and used by him when tied to the foremast of USS *Petral* during the battle of Manila Bay in 1898. These computers located in the Main Battery Plotting Room, below the armored deck, were coupled to two Mark 38 range-finding directors, one located atop the superstructure tower, with the other director located on the aft superstructure just forward of Turret 3. These fire-control computers were able to project the targets' future position, aim the guns for deflection, range, and time-of-shell flight, as well as incorporate a host of atmospheric and ballistic calculations, and allow for ship maneuver, pitch, roll, yaw, and speed. This mechanical/electrical machine performed a task equivalent to that of a quarterback, who uses inherent judgment and muscle-control of a quarterback when throwing a football from his own half to a point in space downfield to which a sprinting wide receiver will reach to catch the ball and score a touchdown.



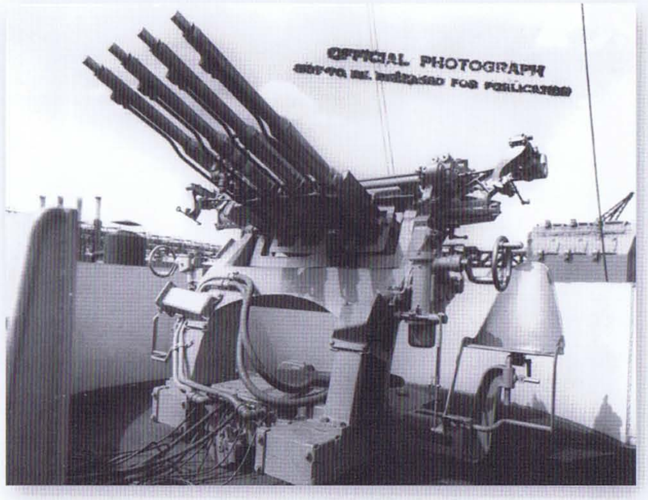
B

USS *SOUTH DAKOTA*

This drawing of the *South Dakota* depicts her at the end of the Pacific war, bristling with 40mm Bofors and 20mm guns.

Built 47ft shorter at the waterline than *North Carolina*, the top-down view clearly shows the hull fairing out from the position of the first 16-inch gun turret.

The profile view readily captures the massive superstructure of bridge, conning tower, and tower with the incorporated funnel. This massive superstructure provided an ample aiming point during the night battle off Guadalcanal, and suffered 15 hits from IJN cruisers and destroyers. *South Dakota* gained a reputation as a jinxed ship: hitting an uncharted coral reef in the Tonga Islands, being hit by 500lb bombs at the battles of Santa Cruz and the Philippine Sea, and suffering the above damage off Guadalcanal, a collision with the destroyer USS *Mahan* and the explosion of a propellant case requiring the flooding of the magazine for turret two while rearming. However, *South Dakota* was credited with downing 31 Japanese aircraft, the largest number by any fast battleship.



A 1.1-inch anti-aircraft gun as originally fitted to *North Carolina*. This gun was prone to jamming if not well maintained. Additionally the weight of bullets fired was insufficient to down an attacking aircraft within the time of the closing range. These guns were replaced by 40mm Bofors.

The secondary armament of dual-purpose 5-inch guns were controlled by four Mark 1 secondary battery computers, located in a separate plotting room. These computers were each coupled with one of the four Mark 37 directors, one forward, one aft, and one either side of the ship. The Mark 1 computer performed the same tasks as the Mark 38, and in addition performed these tasks more quickly for fast-moving targets and calculated altitude of the target in respect of aircraft.

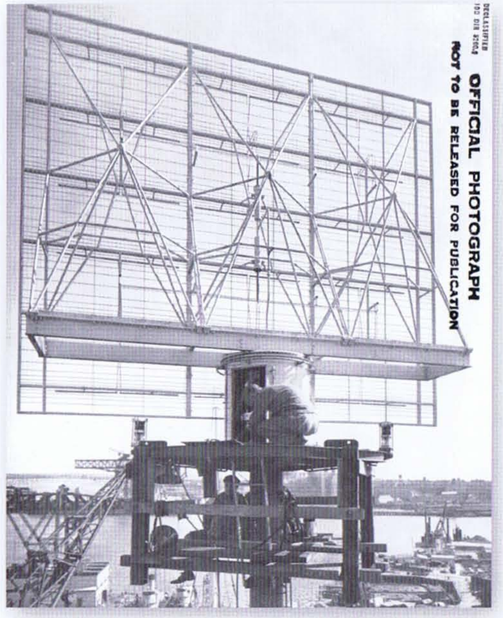
Both plotting rooms also contained a large switchboard that allowed the function of each plot to be switched to its back-up plot located forward of Turret 3 in the event of the primary plot being inoperative. Two plots could also handle separate targets, linking separate directors to one or more gun turrets. Turret 2 also contained main battery plotting instruments to provide a further back up.

Radar

Both the North Carolina and South Dakota class battleships were designed before radar became an integral component of ship design. The *North Carolina* had an air-search CXAM radar installed on her foremast in August 1941. This radar was upgraded to a SK-2 set in March 1943, and in September 1944 upgraded with a SK-2 17ft dish antenna. Mark 3 fire-control radar was installed on top of both fore and aft Mark 38 directors and integrated into the main plot. The Mark 3 was a 40cm radar with a 12-degree beam to provide accurate range and bearing input. This radar was upgraded to a 10cm Mark 8 that scanned at ten scans per second and could range out to 40,000 yards.

Mark 4 fire-control radar, capable of detecting both surface and air targets, was installed only on three of the Mark 37 secondary directors. The aft Mark 37 director was left without a radar antenna, as the height of the intended antenna would have interfered with the Mark 3 radar on the aft Mark 38 director. The Mark 4 was upgraded to Mark 12 and fitted to all Mark 37 directors, as a higher mount had been installed on the Mark 38 director for its radar antenna.

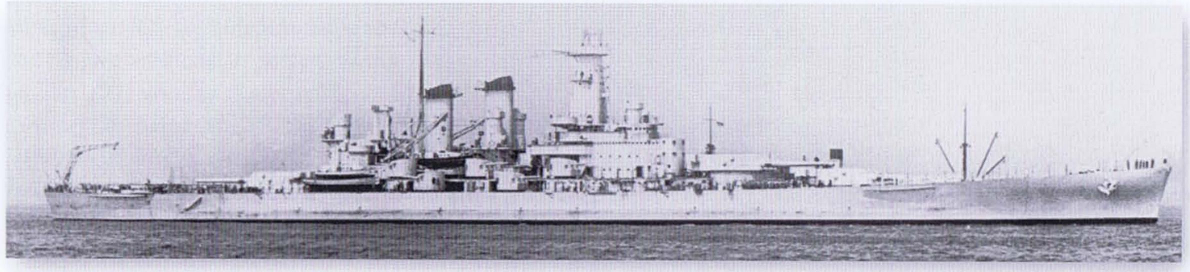
The CXAM-1 air-search radar antenna, referred to as the "bedspring," being fixed to the top of the foremast. Radar was a war-winning technology for the US Navy.



Aircraft

Both the North Carolina and South Dakota class battleships each carried three aircraft, primarily for spotting the fall of shot from the main armament during long-range gunfire. The aircraft were also used for anti-submarine patrols, air-sea rescue, and communicating with shore stations.

Each aircraft, an OS2U Vought Sikorsky Kingfisher, was launched from one of two 68ft catapults located port and starboard at the stern of the ship. Two aircraft were stowed on the catapults with the third aircraft stowed on a dolly between the catapults. The Kingfisher was a single-float aircraft that would land on a slick of still water created by the battleship turning 90 degrees across the wind, then taxi up to the stern of the ship where a hook on the underside of the float would engage a rope sled towed by the ship; the aircraft crane could then reach out to hoist the Kingfisher back on board.



North Carolina in her commissioning light gray paint scheme.

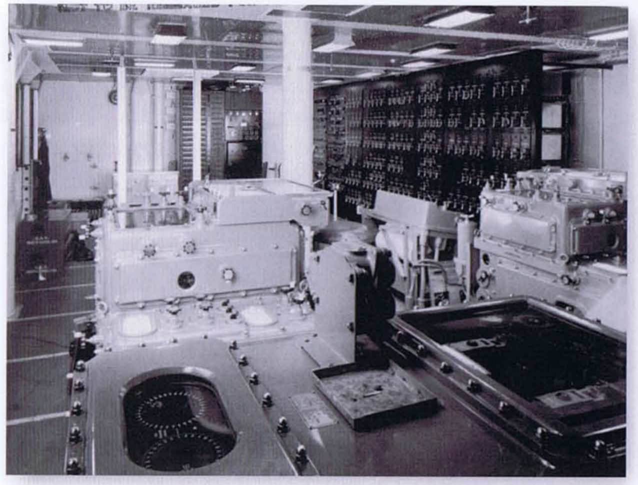
FAST BATTLESHIP OPERATIONS

The North Carolina and South Dakota class battleships were designed for classic line-of-battle conflict. Their high speed, relative to earlier battleships, enabled them to act as a fast wing of the US battle line, counter Japanese fast battleships, and dictate the pace and direction of battle to the enemy battle line. The operative war plans in late 1941, for both the Japanese and US navies, culminated in an Armageddon battleship battle somewhere in the western Pacific.

The naval war in the Atlantic and European waters between September 1939 and late 1941 had already shown the growing lethal capability of carrier-launched and land-based aircraft against warships. Of particular note, on the night of November 11, 1940, Swordfish aircraft from the carrier HMS *Illustrious* attacked the Italian battle fleet in Taranto harbor with torpedoes and bombs, and sank two battleships, damaging a third as well as two cruisers and two fleet auxiliaries. On March 28, 1941, an Albacore aircraft launched from HMS *Formidable* made the first successful air-launched torpedo attack on a battleship underway at sea, when it hit the Italian battleship *Vittorio Veneto*. A torpedo hit on the Italian heavy cruiser *Pola* on the same day led to the battle of Matapan. On May 26, 1941, a Swordfish aircraft launched from HMS *Ark Royal* torpedoed the *Bismarck* at dusk during an Atlantic gale. The hit on the *Bismarck*'s rudder resulted in her being sunk the following day. All these attacks occurred at a range from the carrier greater than the range of a battleship's guns. During May 1941, the German Air Force established air superiority around Crete, and inflicted by dive-bombing severe damage and losses to Royal Navy ships evacuating Allied personnel from the island.

The Japanese carrier air attack on December 7, 1941 with torpedoes and bombs on the US Fleet at Pearl Harbor, and the sinking of the Royal Navy fast battleship HMS *Prince of Wales* and the battlecruiser HMS *Repulse*, operating without air cover, on December 10, by air-launched torpedoes in the South China Sea, brought home

The main battery plotting room showing the Ford Instrument Range Keeper Mark 8, Model 9, calibrated for 16-inch 45 caliber main guns. The main battery fire-control switchboard is shown to the right rear of the picture.



The main battery plotting room manned for action stations. The men are wearing sound activated microphones and headsets to receive input from the main director and radar for input into the Range Keeper.

the vulnerability of battleships to air-launched torpedoes.

The Atlantic

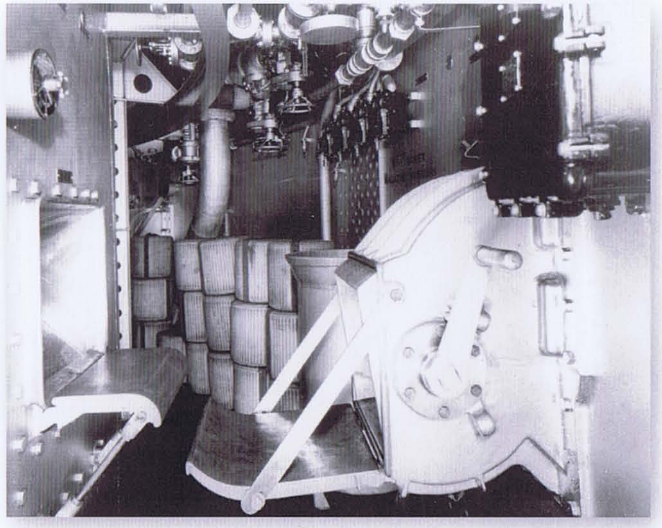
At the declaration of war with Japan and Germany, only two US fast battleships, *North Carolina* and *Washington*, had been commissioned. These two ships were involved with their shakedown and training cruises along the US eastern seaboard. Captain Badger of *North Carolina* requested and received 40 additional 20mm anti-aircraft (AA) guns to bolster his ship's defenses in December 1941. The ships were held on the eastern seaboard to counter the threat of the *Tirpitz* conducting raids on Atlantic convoys. This also reflected the primary US war aim of defeating Germany first, before turning its military and industrial might on Japan.

Washington sailed to join the Royal Navy Home Fleet at Scapa Flow on March 26, 1942, to participate in protecting convoys to Murmansk, Russia. During one such convoy, on May 1, *Washington* was following astern of HMS *King George V*, which collided with an accompanying destroyer, HMS *Punjabi*, cutting her in two. This ship sank in the path of *Washington*, which sailed between the two halves as the depth charges on board *Punjabi* exploded beneath the hull of *Washington*. However, no hull damage occurred. On July 14, 1942, *Washington* left the Royal Navy Home Fleet to return to the US for overhaul prior to sailing to the Pacific.

USS *Massachusetts* was commissioned on May 12, 1942 and on October 28 joined the Western Naval Task force for the invasion of North Africa. US forces were directed to Morocco and the Atlantic port city of Casablanca to secure sea communications to the US. The Vichy French Navy had docked the uncompleted battleship *Jean Bart*, together with a cruiser, ten destroyers, and 11 submarines, in Casablanca. Four shore batteries and a French Army Senegalese battalion guarded the city.

Massachusetts had launched her Kingfisher aircraft at dawn on November 8, and at 6:51am the Kingfishers came under AA fire. Then French fighters attacked the Kingfishers, but were promptly shot down by *Massachusetts*'s 5-inch guns, though not before one Kingfisher was shot down. At 7:01am the El Hank shore battery opened fire on the *Massachusetts* and straddled the ship. At 7:04am *Massachusetts* opened fire on the *Jean Bart* at a range of 24,000 yards, and in so doing was the first US battleship to fire her main armament against an enemy ship since USS *Oregon* fired at the retreating Spanish Fleet at the battle of Santiago on July 3, 1898. Although *Jean Bart* had not been completed, her forward turret of four 15-inch guns was operative and she returned fire at 7:08am, bracketing *Massachusetts*.

Massachusetts had to rely on air spotting to target *Jean Bart*, as her fire-control radar failed as a result of concussive shock from her main guns. Optical range finding was not possible because the French laid down a smoke screen, which together with the smoke and fire from exploding shells obscured the target. In total, *Massachusetts* fired nine 16-inch salvoes and hit *Jean Bart* five times, putting her out of action. These hits represented a 6.17 percent accuracy rate against a stationary target using indirect fire spotted by aircraft. *Massachusetts* next engaged the destroyer *Fougeux*, which had escaped Casablanca harbor and was advancing to make a torpedo attack. *Massachusetts* fired at a range of 11 miles and hit *Fougeux*, which blew up and sank. During this engagement an 8-inch shell fired from the El Hank battery hit *Massachusetts* on her portside deck opposite Turret 2, which penetrated and exploded in a second deck compartment without causing any casualties or serious damage. *Massachusetts* also hit the light cruiser *Primauguet* and the docked destroyer *Le Milan*.



The handling space between the powder magazine and the powder handling room. The transfer hopper with the handle in the up-position receives powder bags from the magazine. The bags are passed through the opposite hopper into the powder handling room where they are hoisted to the gun.

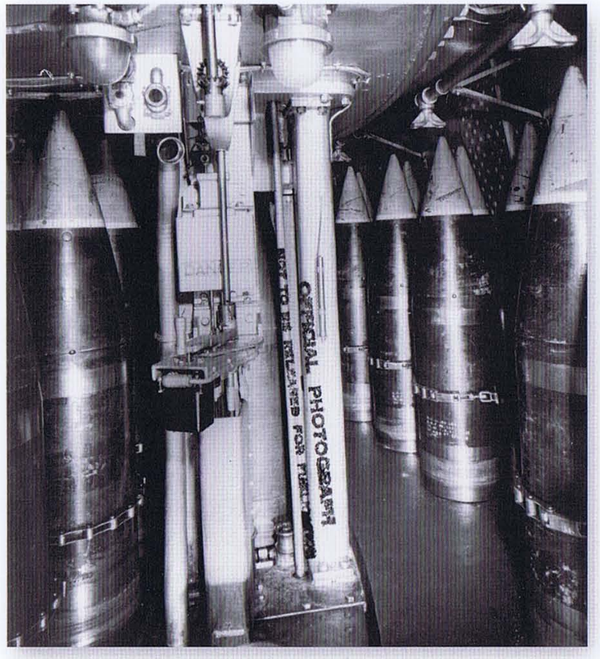
On November 12, *Massachusetts* sailed for the US to prepare for service in the Pacific. It is noteworthy that at the time of the action off Casablanca, *Massachusetts* had been in operation for only six months, which included her shakedown cruise and crew training. Of her total complement of 2,400, 2,000 were new recruits to the navy.

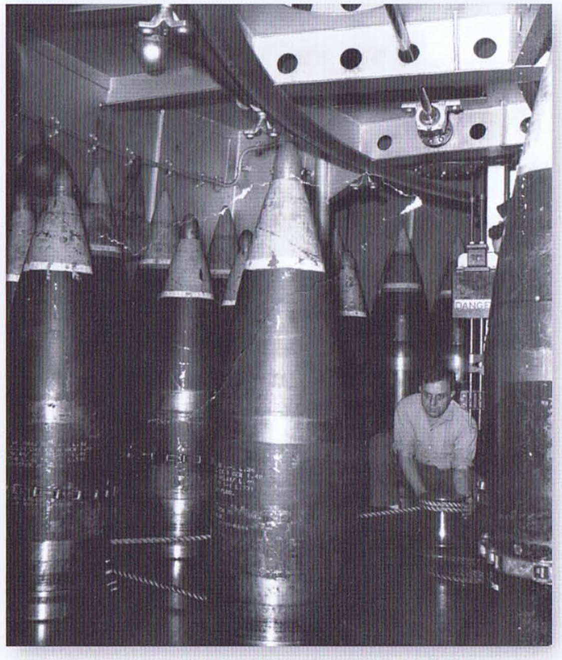
USS *Alabama* was commissioned on August 16, 1942. On April 2, 1943, *Alabama* and *South Dakota* sailed to join the Royal Navy Home Fleet at Scapa Flow to create a diversion for the forthcoming invasion of Sicily. These two battleships guarded against the *Tirpitz* making a foray either into the Atlantic or to raid the Russian convoys. Once this objective was achieved the *Alabama* and *South Dakota* sailed for the US on August 1, 1943 to prepare for service in the Pacific.

The Pacific

The *North Carolina*, commissioned on April 9, 1941, arrived in Pearl Harbor on July 11, 1942, and was the first new major warship to reinforce the outnumbered and embattled US Pacific Fleet. Between the attack on Pearl Harbor and this date, US Navy offensive operations in the Pacific had centered on carriers, supported by cruisers and destroyers. The battles of Coral Sea and Midway had again demonstrated the greater range of aircraft over battleship guns. At Midway, the IJN had employed their carriers in a box formation, and positioned their fast battleships in column formation on the distant beam of the box, or of an individual carrier. In these positions the fast battleships had not been able to successfully defend the carriers, resulting in four being sunk by US Navy carrier-launched dive-bombers.

In 1922, Commander Nimitz was studying at the NWC, and writing a thesis on the battle of Jutland. A key element of this battle was the difficulties Admiral Jellicoe had faced in deploying the 24 battleships of the Grand Fleet from the square cruising formation into line of battle. In searching for an alternative formation using the gaming board, Commander MacFall of the NWC suggested creating a circular cruising formation, with battleships in the center and supporting forces arranged in concentric circles around the battleships. Deployment from this cruising circular formation to line of battle was considered to be quicker and less difficult than from the square formation.





ABOVE
A turret's projectile ring, showing the gap between the revolving floor with its shell hoist and the stationary floor. The sprinkler nozzles over the shells are clearly visible, as are the constraints holding the 16-inch shells in storage.

ABOVE RIGHT
A seaman moving a 16-inch shell via the Parbuckling system. The floor is lightly lubricated, and the seaman uses a winch before him to slide shells on their base into position for storage and loading into the shell hoist.

In 1923, Commander Nimitz was appointed tactical officer on board the fleet flagship USS *California* and introduced the circular formation to the battle fleet. The subsequent integration of the US Navy's first carrier, USS *Langley*, into the formation established that the fleet could readily adapt to the changes in course required by the *Langley* when she launched and recovered aircraft. The circular formation fell out of practice until early 1942 when now Admiral Nimitz became commander in chief of the US Pacific Fleet.

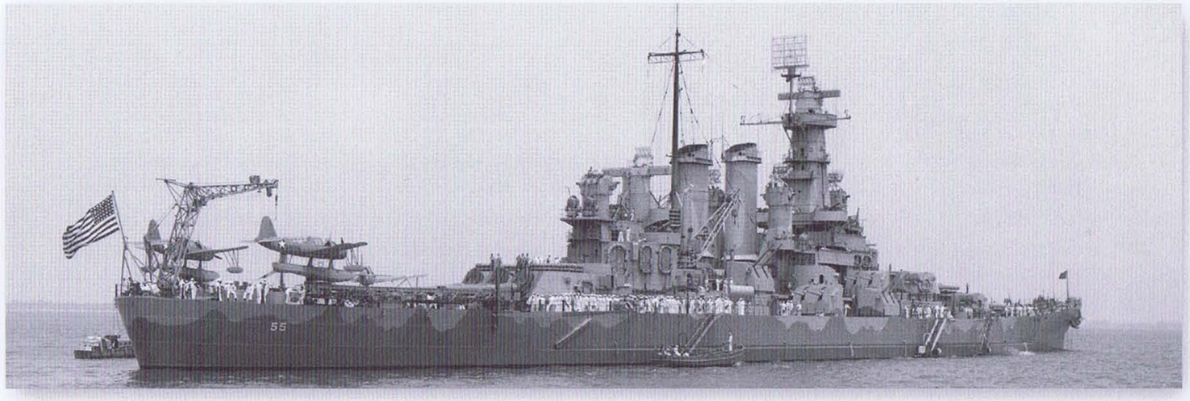
While steaming from the US east coast to Pearl Harbor, the air defense officer of the *North Carolina*, Lieutenant Commander Kirkpatrick, developed the manual for air defense, detailing control and coordination of Sky Control, radar, directors, and the plot to multiple targets. Training for rapid loading of the 5-inch dual-purpose guns was critical, particularly during high-angle firing. Training with the practice loading equipment was a daily regime for 5-inch gun crews. Additionally, the issue of managing the "dead-time" between taking the 5-inch shell out of the fusing pot, which set the fuse time as determined by the fire-control computer, and loading and firing the gun, was key. Time would vary depending on the elevation of the gun, and the stamina and loading skill of the gun crew. A delay of greater than two seconds in this process would mean that the target would move beyond the point of detonation. Kirkpatrick's air-defense manual was distributed to the other fast battleships as they entered the Pacific.

Guadalcanal

The *North Carolina* was assigned to Admiral Fletcher's task force for the invasion of Guadalcanal. The sinking of four IJN carriers at Midway had blunted Japan's expansion and provided an opportunity for the US Navy to commence a major offensive operation. The capture of Guadalcanal would secure sea communications between the US and Australia, from which an Allied thrust through Papua New Guinea to the Philippines would be launched.

During the planning for the invasion, Marine Colonel Maas, assigned to Admiral Fletcher's staff on board the flagship *Saratoga*, prepared a planning memorandum in accordance with NWC methodology entitled "Estimate of the Situation (as of 15 July 1942)." In the section entitled "Operations Plan" Maas proposed that *North Carolina* reinforce the carrier task force, which would provide distant cover to the fire-support and screening group and the US Marine invasion force. Maas expected that Japan would reinforce its Guadalcanal forces under cover of three carriers, two to four battleships, and possibly eight cruisers.

In evaluating Maas's recommendations, Admiral Fletcher sought the advice of Commander Glover, the executive officer of *Saratoga*, as to whether a battleship would add to the overall capability of a fast-carrier task force, given that previous battleships did not have the speed to keep up with the carriers. Glover confirmed Maas's recommendation with the statement, "She can be a great help close in with her tremendous AA power."



Ready for war. *North Carolina* at Norfolk, June 1942, prior to sailing to join the Pacific Fleet. The ship's three Kingfisher aircraft are visible on the stern.

The battle of the Eastern Solomons

Following the successful invasion of Guadalcanal on August 7, 1942, and the capture of the airfield, renamed Henderson Field, by US Marines, it became imperative to the IJN that Henderson Field be either recaptured or put out of operation by air attack and naval bombardment. Then the IJN carriers could engage US carriers without the threat of attack by US aircraft based on Guadalcanal. With Henderson Field out of action, US aircraft would not be able to interdict troop convoys seeking to reinforce Japanese Army troops on Guadalcanal.

After the invasion of Guadalcanal, Admiral Fletcher kept his carrier task force deployed to the south of the island, out of range from land-based aircraft, waiting for the IJN to try to reinforce its Guadalcanal forces. This occurred on August 24, when American scouting planes located Japanese forces. The ensuing battle of the Eastern Solomons saw Admiral Fletcher's carrier-launched aircraft sink the light carrier *Ryujo*. But the two large carriers, *Shokaku* and *Zuikaku*, survived the air attacks and were able to launch a massive air raid of approximately 80 aircraft against *Saratoga* and *Enterprise*.

The *North Carolina* was stationed 2,500 yards astern of *Enterprise* holding the rear position of the circle with *Enterprise* in the middle of the circle. Two cruisers, *Portland* and *Atlanta*, with six destroyers comprised the balance of the circular formation. The formation was steaming at 27 knots and *North Carolina* maintained this speed for over an hour, matching *Enterprise*'s radical course changes to avoid attack. However, during the air attack *Enterprise* increased speed to 30 knots and gradually pulled ahead

C

USS *NORTH CAROLINA*

This image of USS *North Carolina*, depicts her in March 1943, after she had the SK 2 air-search radar fitted.

North Carolina displays the innovative design features that contrast her with pre-1922 battleships. The 120 foot high superstructure tower replaced the tripod and cage masts of earlier ships and provided a more stable environment for main armament fire-control, as well as platforms for conning, sky control, battle lookouts, flag and signal lamp locations, and space for radio and radar antennas. Four propellers and twin rudders made the ship highly maneuverable, while the sweeping weather deck hull form, combined with the bulbous bow, made the ship very seaworthy. During the typhoon of December 18, 1944, *North Carolina* rolled, on average, only 10 degrees, with a maximum roll of 43 degrees.

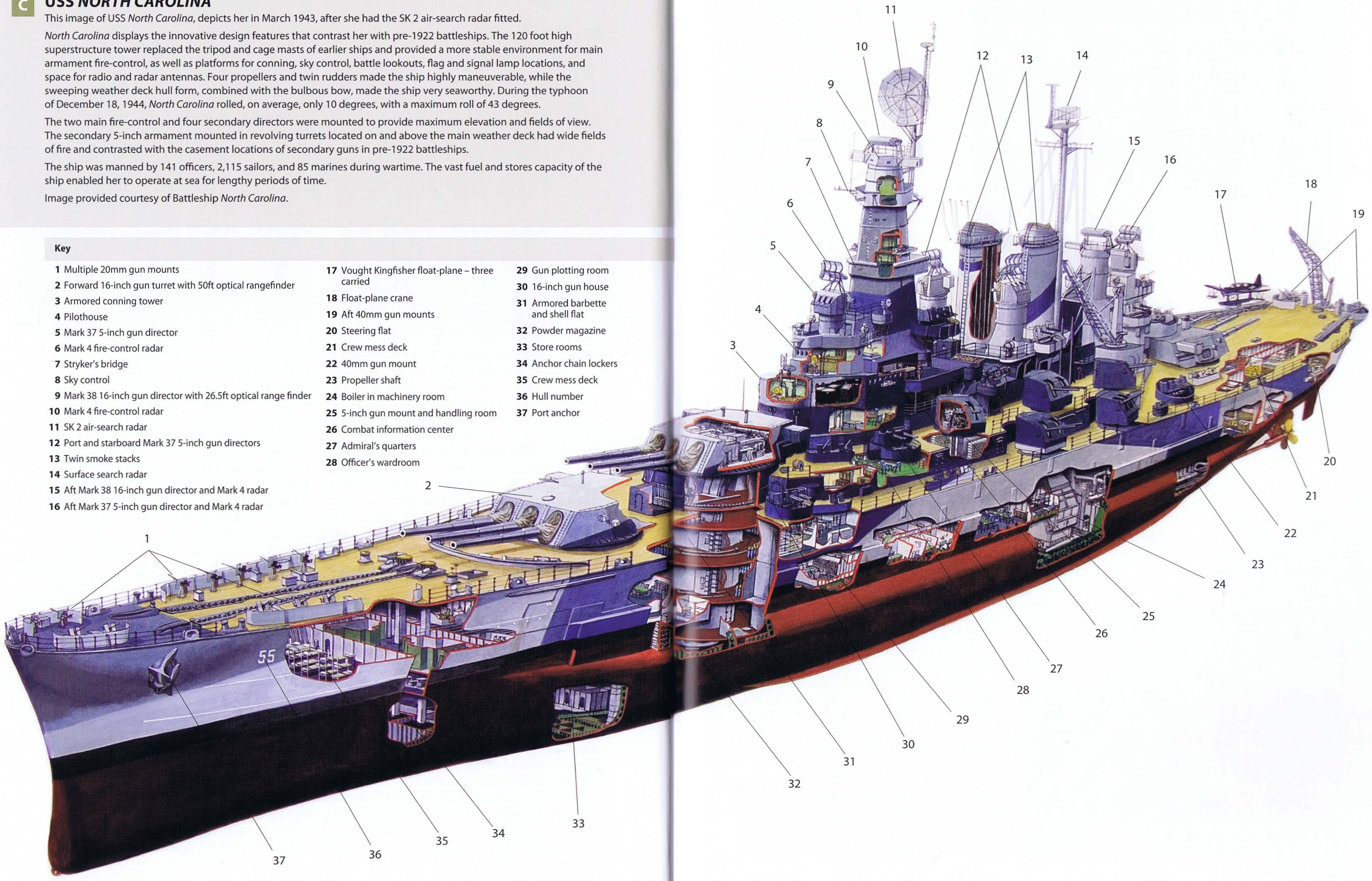
The two main fire-control and four secondary directors were mounted to provide maximum elevation and fields of view. The secondary 5-inch armament mounted in revolving turrets located on and above the main weather deck had wide fields of fire and contrasted with the casement locations of secondary guns in pre-1922 battleships.

The ship was manned by 141 officers, 2,115 sailors, and 85 marines during wartime. The vast fuel and stores capacity of the ship enabled her to operate at sea for lengthy periods of time.

Image provided courtesy of Battleship *North Carolina*.

Key

1 Multiple 20mm gun mounts
2 Forward 16-inch gun turret with 50ft optical rangefinder
3 Armored conning tower
4 Pilothouse
5 Mark 37 5-inch gun director
6 Mark 4 fire-control radar
7 Stryker's bridge
8 Sky control
9 Mark 38 16-inch gun director with 26.5ft optical range finder
10 Mark 4 fire-control radar
11 SK 2 air-search radar
12 Port and starboard Mark 37 5-inch gun directors
13 Twin smoke stacks
14 Surface search radar
15 Aft Mark 38 16-inch gun director and Mark 4 radar
16 Aft Mark 37 5-inch gun director and Mark 4 radar
17 Vought Kingfisher float-plane – three carried
18 Float-plane crane
19 Aft 40mm gun mounts
20 Steering flat
21 Crew mess deck
22 40mm gun mount
23 Propeller shaft
24 Boiler in machinery room
25 5-inch gun mount and handling room
26 Combat information center
27 Admiral's quarters
28 Officer's wardroom
29 Gun plotting room
30 16-inch gun house
31 Armored barbette and shell flat
32 Powder magazine
33 Store rooms
34 Anchor chain lockers
35 Crew mess deck
36 Hull number
37 Port anchor



Practice, practice, practice. 5-inch gun crews use the practice loading machine to improve their loading drill and increase the critical rate of fire during air attack.

of *North Carolina* so that by the end of the action *North Carolina* was 4,000 yards behind *Enterprise*.

At 3:30pm local time, *North Carolina*'s CXAM radar registered Japanese aircraft at 70 miles distance. At 5:11pm dive-bombers were visually sighted and Sky-control took command of air defense. At 5:12pm *North Carolina* opened fire with Mounts 2, 4, and 6 portside 5-inch gun turrets at 15 dive-bombers attacking the *Enterprise*. The 5-inch shells were fused for 1.8 seconds and the volume of fire placed an umbrella of bursting shells over *Enterprise* and caused many of the dive-bombers to break from their attack.

At 5:13pm the *North Carolina* came under attack by ten dive-bombers attacking the starboard beam. Mounts 1, 3, and 5 starboard-side 5-inch gun turrets opened fire and turned away several of the bombers. Only three bombs were dropped and they all missed.

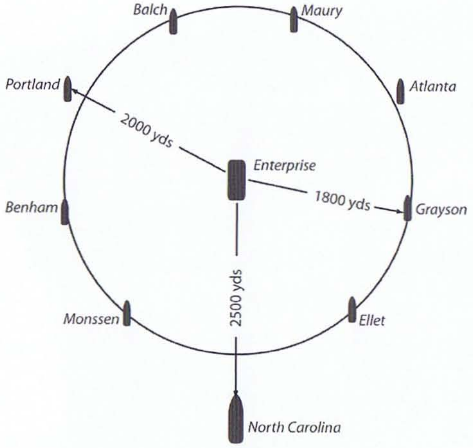
Next, torpedo and glide bombers attacked the ship from different directions and the full AA armament opened fire – 20 5-inch guns, 16 1.1-inch canons, 40 20mm, and 26 50-caliber machine-guns. The resultant volume of fire, with accompanying sheets of flame, tracers, and smoke from the guns, was such that Admiral Kinkaid on board *Enterprise* signaled "Are you on fire?" No one had seen a fast battleship fire all its guns in action before.

At 5:15pm a further dive-bombing attack was made by four aircraft on the port quarter with four bombs landing close to the port and starboard catapults, resulting in a volume of water coming on board that knocked the aft 20mm gunners down. *North Carolina* was not hit during the attacks, but one attacking aircraft strafed the ship with machine-gun fire and killed one sailor, a loader on an aft 20mm gun. During the action, *North Carolina* gun crews fired 841 5-inch shells, 1,067 1.1-inch shells, 7,425 20mm shells, and 8,641 50-caliber bullets. The decks around the 5-inch gun turrets were covered with shell casings, ejected from the 5-inch guns after being fired.

The attacks were over by 5:20pm and *North Carolina*, in what the crew described as "seven minutes of hell," was credited with destroying seven aircraft and possibly 14. But her more noteworthy action was in using her 5-inch guns to defend *Enterprise*, which was the main target of the attack. *Enterprise* suffered three bomb hits, but her damage-control crews were able to contain the damage and *Enterprise* was able to recover aircraft and continue at full speed.

Having failed to sink the two US carriers, and having lost one carrier and 42 aircraft shot down by US carrier aircraft and AA fire, the IJN forces withdrew. The planned reinforcement of Guadalcanal with a troop convoy sailing without air cover was stopped and devastated on August 25 by US Marine and Navy aircraft flying from Henderson Field.

US formation of the battle of the Eastern Solomons.



Mark 1 Eyeballs supplement radar to spot incoming aircraft.

The battle of the Eastern Solomons was a critical strategic success for the US Navy, and another major carrier victory for Admiral Fletcher, along with Coral Sea and Midway. While stopping Japan reinforcing its troops on Guadalcanal and inflicting on it a further carrier loss and the destruction of naval aircraft and crews, the actions of *North Carolina* in the battle established a new role for fast battleships as close-in AA escorts to fast carriers. Additionally, the battleship's traditional role of providing big-gun firepower was seen as critical during nighttime when carriers were vulnerable to surface ships.

After the battle Admiral Kinkaid signaled Admiral Nimitz in Pearl Harbor, "The presence of a fast battleship in Task Force 16 ... during action on 24 August was a distinct asset because of her demonstrated fire power against attacking aircraft and her inherent strength against possible surface contacts. ... the station of the *North Carolina* in cruising disposition and particularly in tight screening dispositions during air attacks should be downwind from carrier as was the case on 24 Aug with thoroughly satisfactory results."

The combination of mutually supporting fast carrier and fast battleship in a task force created for the US Navy an unbeatable weapon system. No carrier escorted by a fast battleship was lost to air attack, and no fast battleship was lost during the remainder of the war.

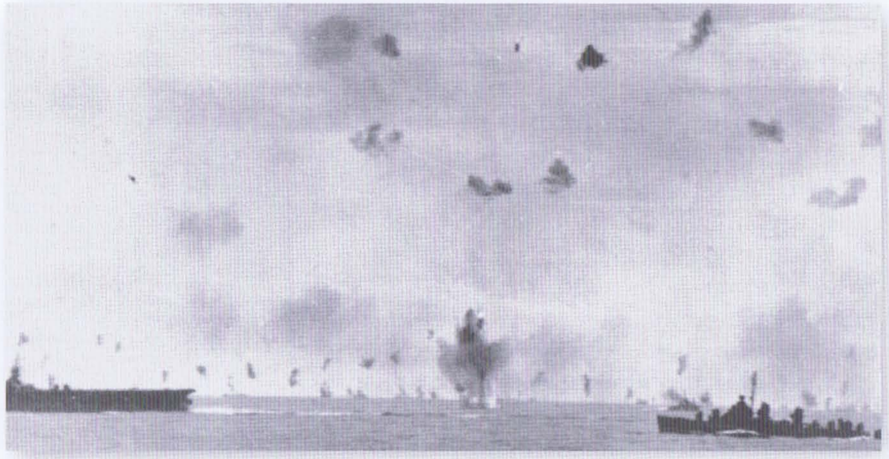
The unique and first-time role *North Carolina* played in the battle was reflected in Captain Fort's After Action report for the ship. Notwithstanding that his was the latest and most powerful battleship in the US Fleet, Captain Fort wrote in his opening paragraphs that "The *North Carolina* was operating with Task Force 16 as a cruiser." This statement indicates that at the time of his writing, the US Navy had yet to formulate a role for the new fast battleships working with fast carriers. In the absence of a formalized role, operational necessity, as determined by the admirals on the spot, Fletcher and Kinkaid, resulted in fast battleships being used as close-in AA escorts to fast carriers.

For *North Carolina*, four elements of the battle proved unsatisfactory:

- 1.1-inch cannon
  The 1.1-inch cannon did not deliver sufficient weight of shells to down an aircraft during its attack mode. Kirkpatrick noted that this gun was liable to break down due to weak recoil and ejection systems. These guns were subsequently replaced with four-barrel 40mm Bofors guns.
- Conning during air-attack
  The executive officer, Commander Stryker, conned the ship during the air attack from a secondary conning position located at level seven, mid-way up the superstructure

Baptism of fire. Battle of the Eastern Solomons. *Enterprise* taken from the yardarm of *North Carolina* under air attack, but protected by an anti-aircraft umbrella. Note the row of splashes from a 20mm gun between the ships.

A Japanese plane splashes astern of USS *Enterprise* during the battle.



tower. Visibility was severely limited through battle-slits cut into the skin of the tower. Stryker subsequently had a walkway built around the outside of the tower at the secondary conning level, so that he had unrestricted visibility in future battles.

- Sky Control and radar overwhelmed
  Sky Control, directors, and the radar system missed locating a number of heavy bombers at 15,000ft that attacked *North Carolina* at the same time as the torpedo and glide bombers. Fortunately the released bombs fell between *North Carolina* and *Enterprise*.
- Sea impact on bow gunners
  Sailing at full speed resulted in significant spray and water coming over the forecastle and adversely impacting the forward 20mm gunners.

Torpedo attack

On September 15, 1942, the IJN submarine I-19, on picket patrol south of the Solomon Islands, fired six Type 95 torpedoes at the carrier USS *Wasp*. Three torpedoes struck the *Wasp*, which eventually sank. Two of the three torpedoes that missed the *Wasp* continued their run, with one hitting the destroyer USS *O'Brien* and blowing off her bow. The other torpedo struck *North Carolina* on her port side adjacent to Turret 1 at 2:52pm, killing five sailors and wounding 23. The 891lb warhead in the torpedo blasted a hole

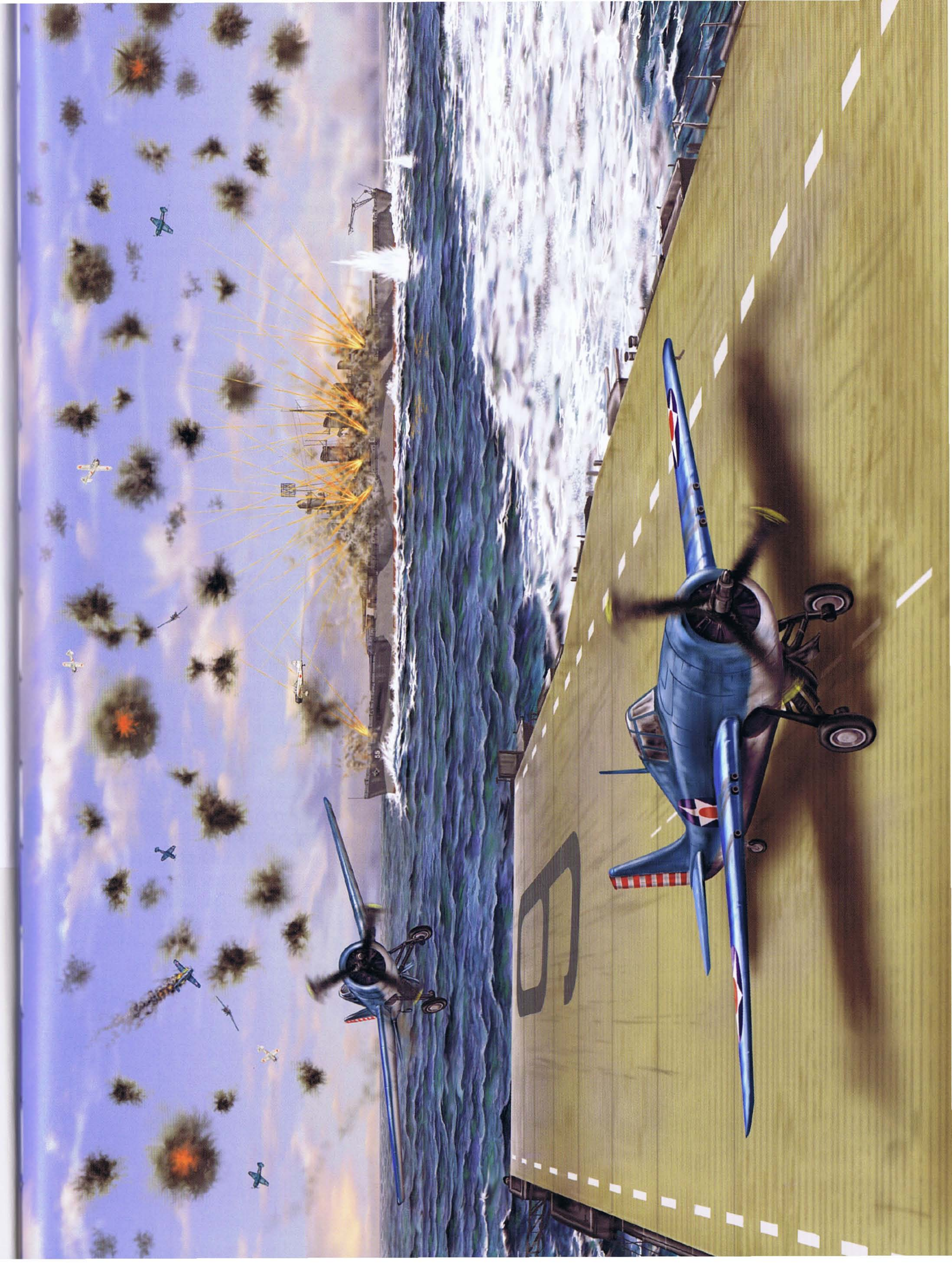
D

"SEVEN MINUTES OF HELL"

This picture captures the moment when the *North Carolina* opened fire with all her AA guns to ward off a simultaneous and coordinated attack by Japanese dive-bombers and torpedo planes. At the same time, *North Carolina* is firing her 5-inch guns at Japanese aircraft attacking *Enterprise* by placing an umbrella of exploding shells over this ship, which the attacking aircraft have to penetrate in order to release their bombs. Until this moment, no one had witnessed the amount of AA gunfire a fast battleship could produce. Admiral Kinkaid on board the *Enterprise* signaled *North Carolina*, "Are you on fire?" A Japanese aircraft, after releasing its bomb, flew alongside *North Carolina* for the first view of this new US battleship.

North Carolina is following astern of *Enterprise*, and both ships are twisting and turning to avoid falling bombs and torpedoes. *Enterprise* has increased speed to her maximum 33 knots, but *North Carolina* can only manage 27 knots and will eventually fall behind *Enterprise* by two miles; however the range of her 5-inch guns still protects the *Enterprise*.

The AA performance of *North Carolina* in the battle of the Eastern Solomons, notwithstanding her lack of the new 40mm Bofors gun, led to the new role for fast battleships as close-in AA escorts for carriers, and no US carrier escorted by a fast battleship was sunk by air attack for the rest of the war.



Empty shell casings litter the deck from a 5-inch gun mount, with the practice loading machines in the background.

32ft long and 18ft high in the hull, 20ft below the waterline. The first torpedo bulkhead between frames 46 and 50 was demolished and the next two torpedo bulkheads were forced inboard with 1,000 tons of water taken on board creating a 5-degree list to port. This list was corrected within five minutes by counter-flooding on the starboard side. Flooding water reached the handling room for Turret 1 and burning oil from ruptured oil tanks entered the forward magazine, but the activated sprinkler system extinguished the flames. *North Carolina* was able to increase speed to 25 knots and maintain her position screening the carrier USS *Hornet*. The shock from the explosion put the search radar at the top of the foremast out of action.

Following temporary repairs at Tongatabu in the Tonga Islands by the repair ship USS *Vestal*, *North Carolina* sailed to Pearl Harbor, where she arrived on September 30 and stayed until November 17, 1942 for permanent repairs. While in Pearl Harbor the 1.1-inch canons were removed and replaced by 15 mounts of four-barrel 40mm Bofors guns. The walkway around level seven of the superstructure tower was also constructed, and thereafter referred to as "Stryker's Bridge." This walkway was unique to *North Carolina* and helped identify the ship from her otherwise twin, *Washington*.

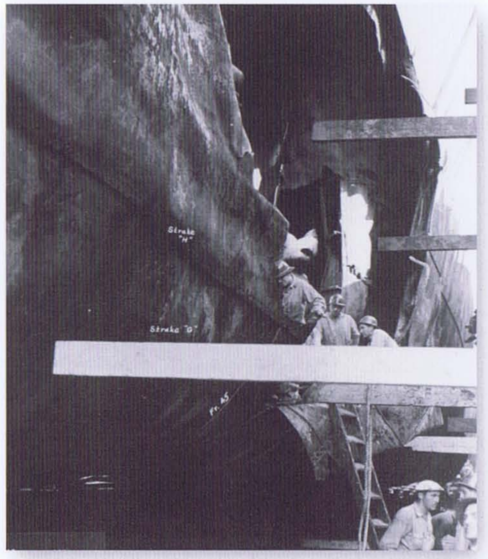
South Pacific reinforcements

On September 4, 1942, *South Dakota* arrived in Tonga after her commissioning on March 20, 1942. On September 6 she hit an uncharted coral reef and damaged her hull bottom. The repair ship *Vestal* had her divers check the ship's hull and seams. The divers reported the damage as a series of splits extending 150ft along the ship's bottom. By September 8, *Vestal*'s repairmen, together with men of the battleship's crew, managed to mend the damage sufficiently to allow the ship to leave for Pearl Harbor for permanent repairs. *South Dakota* returned to the South Pacific on October 24 as part of Task Force 16, escorting *Enterprise*, which had also been repaired at Pearl Harbor from the damage incurred in the battle of the Eastern Solomons.

The Japanese Navy submarine I-19, which fired the most successful torpedo spread of the war. Three torpedoes hit the *Wasp*, another the destroyer *O'Brien*, and the fifth torpedo hit the *North Carolina*.

On September 14, *Washington* arrived in Tonga, after her commissioning on May 15, 1941, and Admiral Willis "Ching" Lee joined the ship as commander, Battleship Division 6. US naval forces continued to cover troop and supply convoys to Guadalcanal from New Caledonia.

Anticipating a further major attempt by Japan to reinforce its troops and recapture Guadalcanal, on October 23, *Washington*, three cruisers, and six destroyers were ordered to patrol south of Guadalcanal to cover the "slot." *Enterprise*, *South Dakota*, *Hornet*, and accompanying cruisers were to sail towards the Santa Cruz Islands located to the east of Guadalcanal to prevent any Japanese forces moving south on the Pacific side of the Solomon Islands chain.



I-19's torpedo caused a hole 32ft long and 18ft in depth in *North Carolina*'s port side adjacent to the forward main gun turret.

Battle of Santa Cruz

The battle of Santa Cruz took place on October 26, 1942. The IJN Combined Fleet was organized with the three carriers, *Shokaku*, *Zuikaku*, and the light carrier *Zuiho* as the Carrier Striking Force. A Vanguard Group of two fast battleships, *Hiei* and *Kirishima*, and three cruisers preceded the carriers and was intended to provide a target for attacking US carrier aircraft and thereby blunt any attack on the following carriers. Additionally, the Vanguard Group was to hunt down the US carrier force once located and slowed by attacks from the carriers. An Advance Group of five cruisers with two fast battleships, *Kongo* and *Haruna*, and the carrier *Junyo* was to attack Henderson Field.

Once scouting forces from both sides had located each other's main carrier forces, air attacks were launched, which passed each other in mid-air on their way to their respective targets. *Hornet* and her four accompanying cruisers were operating ten miles from *Enterprise*, *South Dakota*, and two cruisers. A line of tropical squalls covered *Enterprise* and her escorts. The first air attack of 36 torpedo and dive-bombers focused on the *Hornet* at 10:09am; she suffered two torpedo hits on her starboard side and three bomb hits by 10:14am, had to be subsequently abandoned, and eventually sank.

The next wave of attack comprising 20 dive-bombers commenced at 11:12am on the stern of the *Enterprise*. *South Dakota* was stationed 1,000 yards off *Enterprise*'s starboard side and opened fire. The second attack comprised both torpedo and dive-bombers, which approached from different directions and were well coordinated to create multiple attacking points. This attack lasted until 11:52am. The *Enterprise* was hit by two bombs during the attack, but was still able to steam and operate aircraft. *Enterprise* also landed a large number of *Hornet*'s aircraft, as that carrier slowly succumbed to the damage she had sustained, and found herself with her flight deck inoperative.

At 12:19pm a further wave of 24 torpedo and dive-bombers attacked from off *South Dakota*'s port bow, using the low cloud of the squall line to hide their approach. At 12:29pm a dive-bomber appeared from a 1,000ft cloud base on the port bow and scored a hit on *South Dakota*'s number one 16-inch gun turret with a 500lb bomb. While this turret remained operative, the bomb damaged two 16-inch gun barrels of Turret 2, which was trained over Turret 1. Shrapnel from the exploding bomb killed one sailor and wounded 49 others, including Captain Gatch. The captain had left his position inside the heavily armored conning tower with its limited visibility to improve his view of the attacking aircraft, and had stationed himself on the open catwalk outside the conning tower, above and behind Turret 2.

I-19's torpedo also buckled the revolving deck within *North Carolina*'s powder handling room.

The *Enterprise* and *South Dakota* were the only ships armed with the new 40mm Bofors gun. The shells from this gun were heavier than shells from the 1.1-inch canon and far more effective against attacking aircraft. The 40mm shells were fused to explode at 4,000ft, providing a curtain of exploding shells through which attacking aircraft had to penetrate. Additionally, ships in the *Enterprise* group carried in total 108 20mm guns versus 52 in the *Hornet*'s group. The high rate of fire from these 20mm guns was particularly effective against low-flying aircraft and accounted for the majority of the 26 aircraft that *South Dakota* claimed.

Aircraft from *Hornet* severely damaged *Shokaku* and the cruiser *Chikuma*, and aircraft from *Enterprise* bombed *Zuiho*. Both of these Japanese carriers required extensive repairs in Japan as a result of this battle. As important, Japan lost 99 aircraft and 145 aircrew from its small population of battle-trained airmen.

South Dakota entered the battle only seven months after her commissioning. Her crew contained a large percentage of men new to the navy and who manned the 20mm guns on the ship's exposed decks. This new crew and the crews of the other ships were exposed to unrelenting air attacks as a result of misdirection to *Enterprise*'s combat air patrol by fighter-direction officers that allowed Japanese aircraft to attack unopposed by defending fighters. Therefore the AA guns of *Enterprise*, *South Dakota*, and the two cruisers became the primary defense against attacking aircraft.

Naval battles of Guadalcanal

The successful battles of the Eastern Solomons and Santa Cruz, together with aircraft from Henderson Field, gave the US Navy and Marines control of the air over and around Guadalcanal and up the slot during the day. The US Navy was therefore able to supply and reinforce the Marines fighting on Guadalcanal, and in particular defending Henderson Field against Japanese troops. However, during the night when aircraft could not operate, the IJN was able to land troops and resupply its existing troops on the island, and

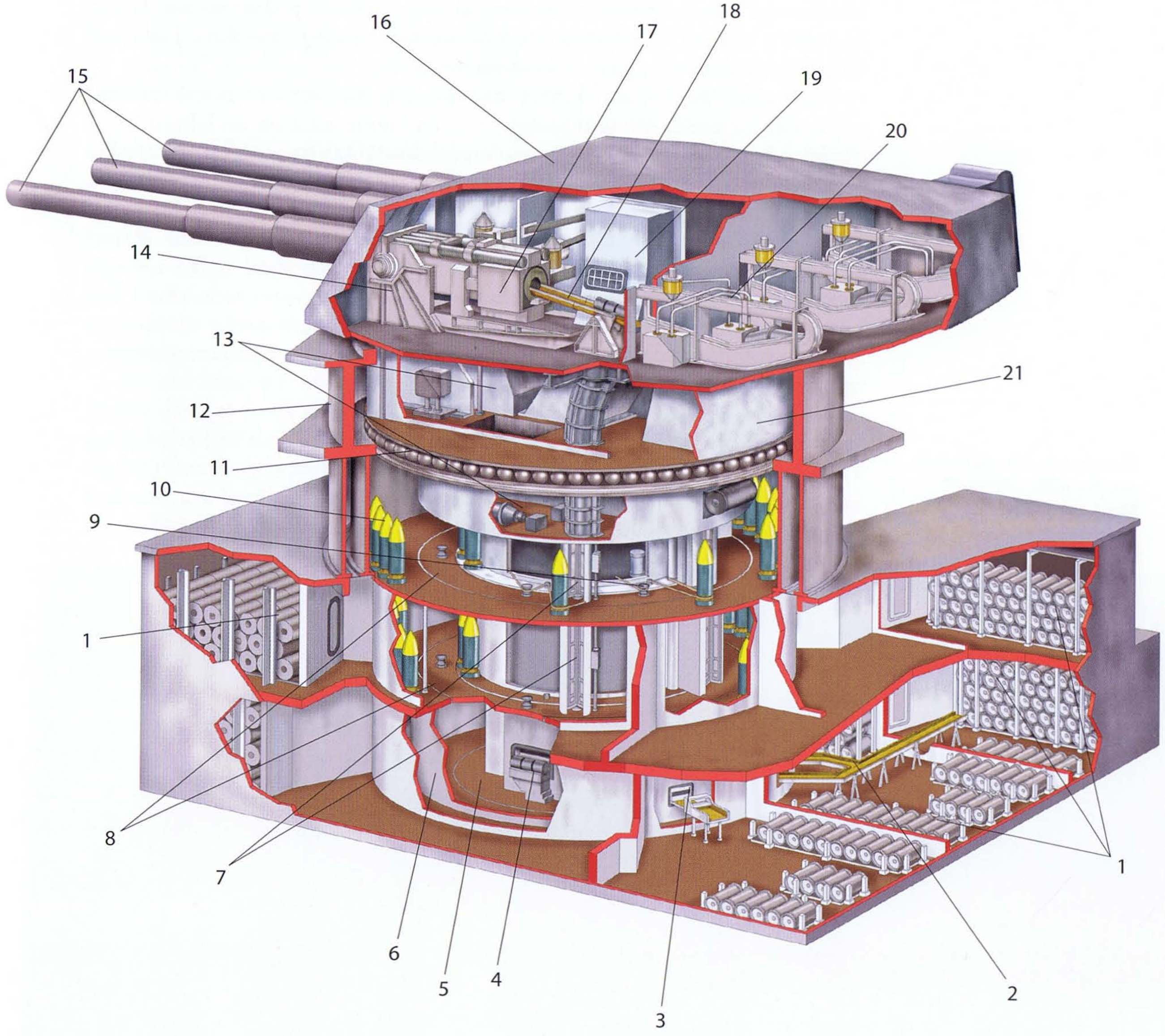
E

16-INCH GUN TURRET

The 16-inch gun had a range of 36,900 yards, a muzzle velocity of 2,300 feet per second, and could fire two types of shell: a 2,700lb armor-piercing shell capable of penetrating 20 inches of armor at a range of 15,000 yards, for use against armored ships or fortified emplacements, or a 1,900lb high-capacity shell for use against unarmored ships or soft land targets.
The magazine, storing the powder charges, was positioned on the lower two levels of the ship. The charges were stored in canisters, stacked in racks. When needed, they were removed from their canisters, moved along a conveyor to a powder scuttle, and passed through to the powder handling room. Here, six charges would be loaded into an electric hoist and raised to the gun house to either the left or the right of the gun breech. Above the powder handling room, two decks – the projectile rings – stored the 16-inch shells. Shells were loaded into a hoist which lifted them up an enclosed tube to the gun house, where it would exit the hoist to the rear of the gun. The end of the tube hoist comprised a tilting tray that moved the shell from the vertical to a 5-degree horizontal loading position, and formed a loading tray to span the space between the hoist and the gun breech. A rammer would then push the shell into the breech. The door to the powder hoist would then be opened towards the loading tray, creating a shelf for the charges to slide into the loading tray, from where they would then be slowly rammed into the breech. After inserting a firing pin, the breech was closed and the gun fired.

Key

1	Powder magazine
2	Powder conveyor
3	Scuttle from magazine to annular space
4	Powder hoist
5	Powder handling room
6	Annular space
7	Shell hoist
8	Shell decks
9	Parbuckle capstan
10	16-inch shells
11	Roller path
12	Armored barbette
13	Machinery decks
14	Deck lug
15	16-inch gun barrels
16	Armored gun turret
17	Gun breech
18	Spanning tray
19	Powder hoist
20	Rammers
21	Rotating turret structure



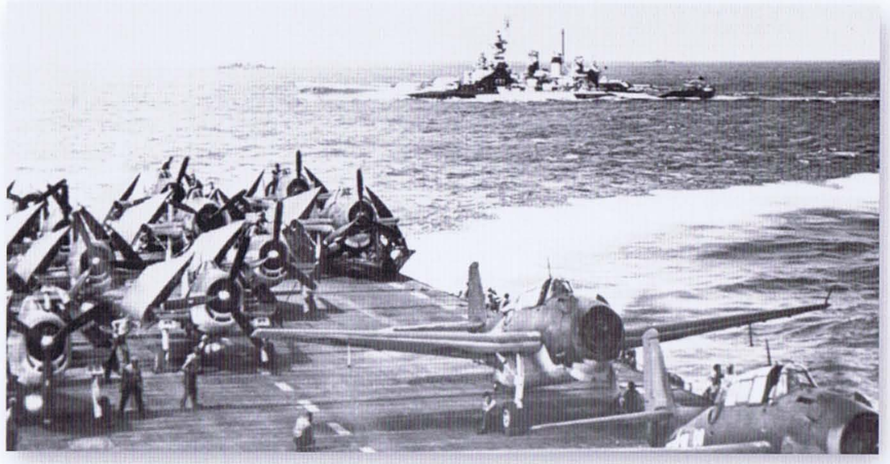
then bombard Henderson Field. The US Marines named this nightly bombardment "The Tokyo Express."

The US Navy had cruisers, destroyers, and Motor Torpedo Boats (MTBs) standing guard on the seaward side of Henderson Field in Savo Sound, between Guadalcanal and Florida Islands. However, only a few of the larger ships had radar, and experience in its use was limited. Additionally, the northern sea approach to Guadalcanal was bisected by Savo Island and also guarded. The IJN had trained vigorously for night battle, including the launching of "Long Lance" torpedoes before firing their guns to achieve maximum surprise. In a series of night battles, Savo Island, Lunga Point, Cape Esperance, and the first battle of Guadalcanal, the IJN sank four US cruisers, one Australian cruiser, and seven destroyers. In these battles the IJN lost one cruiser and four destroyers. In addition, the IJN bombarded Henderson Field on a regular nightly basis. However, despite the nightly bombardment, Henderson Field remained operative and on November 14, 1942 Marine and Navy aircraft sank a heavy cruiser and the fast battleship *Hiei*, both of which had been severely damaged by US cruisers during the first battle of Guadalcanal, as well as six troop transports.

Following these naval losses, and anticipating further bombardment of Henderson Field, Admiral Halsey, who had replaced Admiral Ghormley as commander South Pacific Forces, ordered Admiral Lee to position his flagship *Washington* and the *South Dakota* plus four destroyers to the north of Savo Island to intercept any IJN forces steaming south to Savo Sound. This was a high-risk operation for these new high-value battleships, as the waters around Savo Sound were not well charted, with the potential for a large ship to hit unknown coral reefs. The waters were also narrow for large ships, and without sufficient maneuvering room they were vulnerable to torpedo attacks. Additionally, the battleships and destroyers were a scratch force, having never operated together before.

As night approached on November 14, 1942, Admiral Lee moved his task force north of Guadalcanal and eastwards to the northeast of Savo Island. The four destroyers in line ahead preceded *Washington*, with *South Dakota* astern. A US submarine, *Trout*, on patrol up the slot radioed that she had spotted large enemy units moving south. This comprised a bombardment group, centered on the fast battleship *Kirishima*, four cruisers, and nine destroyers, followed by a convoy of troop transports.

Dauntless dive-bombers circle over the *North Carolina* in March 1944 as the ship sails towards Emirau Island.



The *North Carolina* passing astern of a US carrier.

Admiral Lee turned his force south to move into Savo Sound. At this point Lee heard over the tactical voice radio talk between patrolling MTBs that they had spotted Lee's task force but did not know if it was Japanese or US. Admiral Lee used the "talk between ships" radio to talk to the MTBs using his Naval Academy nickname "Ching" for identification, saying, "This is Ching Chong China Lee. Refer your big boss about Ching Lee. Call off your boys!" With identity established, Admiral Lee then circumnavigated Savo Island, finally heading northwest between Savo Island on his starboard bow and the northern tip of Guadalcanal named Cape Esperance on his port bow. In addition to his colorful nickname, Admiral Lee was an expert on radar and gunnery, and this would be a major factor in the action about to unfold.

At 00:01am on November 15, *Washington*'s radar located Japanese ships to the east of Savo Island at a range of 18,500 yards. With the aid of moonlight, visibility was approximately nine miles. At 00:16am *Washington* opened fire with *South Dakota* following one minute later. This represented the first time a battle line formation of US battleships opened fire on enemy ships. The fire from *Washington* totaled 42 16-inch shells and was held until 00:19am. The target was the cruiser *Sendai*, which laid down a smoke screen and quickly retired without damage. Both battleships fired their 5-inch secondary batteries at Japanese destroyers at a range of 15,000 yards.

At 00:20am Lee's four destroyers opened fire on Japanese ships approaching from the northwest side of Savo Island. Within 20 minutes, two destroyers, USS *Walke* and *Preston*, were blazing wrecks and sinking, with the other two, USS *Gwin* and *Benham*, badly damaged and retiring from action.

During this same 20-minute period, *Washington* and *South Dakota* fired both main and secondary armaments intermittently at targets appearing from around Savo Island to their northeast. The destroyer *Ayanami* was hit with two 5-inch shells from *South Dakota* later in the night.

At 00:33am the concussive shock from firing all bearing guns caused an electrical

20mm gun crews at the ready.

short circuit on *South Dakota*, which tripped a circuit breaker incorrectly connected to the ship's electrical system. Her radar, fire-control circuits, turret motors, ammunition hoists, and radios became inoperative until power was restored at 00:36am. At this time, *South Dakota* veered to her starboard to avoid the blazing wrecks of *Walke* and *Preston* and was subsequently silhouetted when passing them, providing enemy forces with an illuminated target. *Washington* ahead of *South Dakota* had turned to port keeping the wrecks on her engaged side and so remained invisible to the Japanese.

At 00:42am, *South Dakota*'s Turret 3 firing over her stern set fire to her two Kingfisher aircraft. The next salvo from this turret then blew the two aircraft overboard and dampened the fires. *South Dakota* was now visible to the Japanese, who then turned on their searchlights, focusing on her superstructure. *South Dakota* became their primary target at 00:48am and suffered a hail of fire of 26 hits, with 15 of these on her bridge and superstructure. Fourteen of these hits were by 8-inch shells and one by a 5-inch shell. Turret 3 was hit by a 14-inch shell fired by the battleship *Kirishima* that detonated against the turret barbette but did not penetrate the armor. This hit locked the turret in place and did extensive damage to the deck. The integrity of the ship was not damaged, but her command and control were severely weakened both by casualties amongst officers and crew, and by damage to radar, fire-control circuits, and communication equipment. *South Dakota*, now ineffective as a fighting unit and unable to locate the position of *Washington*, withdrew from the battle, leaving *Washington* to face the Japanese fleet alone.

At 00:58am, the moon set and visibility dropped from nine miles to less than three within minutes. *Washington* had been firing her 5-inch guns at the

F

NIGHT BATTLE OFF GUADALCANAL

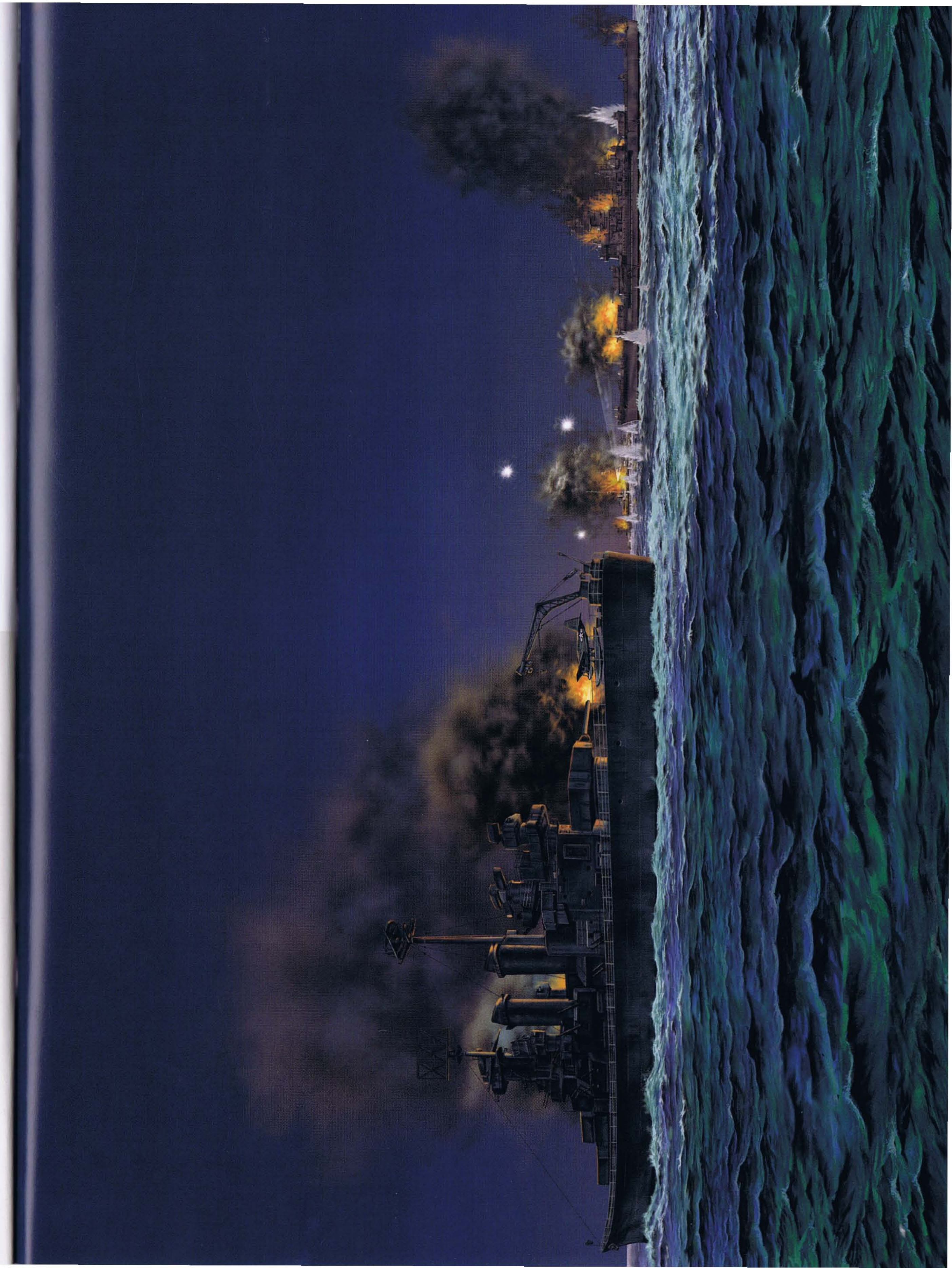
This picture depicts the *Washington* at 01:02am on November 15, 1942, when she is firing her third salvo of 16-inch guns at the IJN fast battleship *Kirishima*. The opening salvos, fired at a range of 8,400 yards, have started a fire amidships on board *Kirishima* in its starboard secondary casements. *Kirishima* is illuminated by multiple star shells fired by the starboard stern 5-inch gun turret on board *Washington*.

Washington and *Kirishima* are approaching each other with a combined speed of 54 knots, rather than on parallel courses in the classic battleship duel tactic. This approach and the high speed means that the change of rate is high and the amount of lead-off for deflection is also high, rather than the constant bearing that a parallel course would create. In the first two minutes and 29 seconds *Washington* fires 39 16-inch shells at *Kirishima*. Then *Washington* ceases fire for 90 seconds, as reports advise the target is sunk. However, when *Kirishima* opens fire on *Washington*, the latter returns fire for another three minutes and sends 36 16-inch shells towards *Kirishima*, which then ceases fire and turns to port. *Washington* ceases fire, aware that *South Dakota* is somewhere astern and off her starboard quarter, and Admiral Lee assumes she is nearing the same bearing as *Kirishima*.

To the right of the picture is *South Dakota*, which has been illuminated by searchlights from the IJN cruisers *Atago* and *Takao* and is being heavily hit by these ships as well as *Kirishima*. *South Dakota* is hit 26 times by Japanese shells. Although her armor belt is not penetrated, and the ship is able to steam and maneuver, her fighting capability has been rendered inoperative through damage to the command and control officers, crew, and equipment located in the bridge and superstructure tower. *South Dakota* withdraws from the battle.

Kirishima sinks in the early hours, as her crew is unable to control the flooding caused by the hits from *Washington*.

Admiral Lee and *Washington* achieved a major victory over the IJN, which was unable to bombard Henderson Field or protect the troop transports bringing reinforcements and supplies, which were destroyed in the morning by US aircraft flying from Henderson Field. However, the uncertainty of not knowing where *South Dakota* was located relative to his position made Admiral Lee cautious when considering future night surface battles.



20mm gunners on the *North Carolina*'s forecastle during an air attack off Okinawa, April 1945.

Japanese searchlights and had located the battleship *Kirishima* by the size of her radar return. At 01:00am *Washington* opened fire on *Kirishima* with her main armament. *Washington* and *Kirishima* were on nearly opposite courses. *Washington* was steering northwest, 290 degrees at 26 knots, and *Kirishima* steering southeast, 130 degrees at approximately 28 knots, a passing speed of 54 knots at a distance of 4,800 yards.

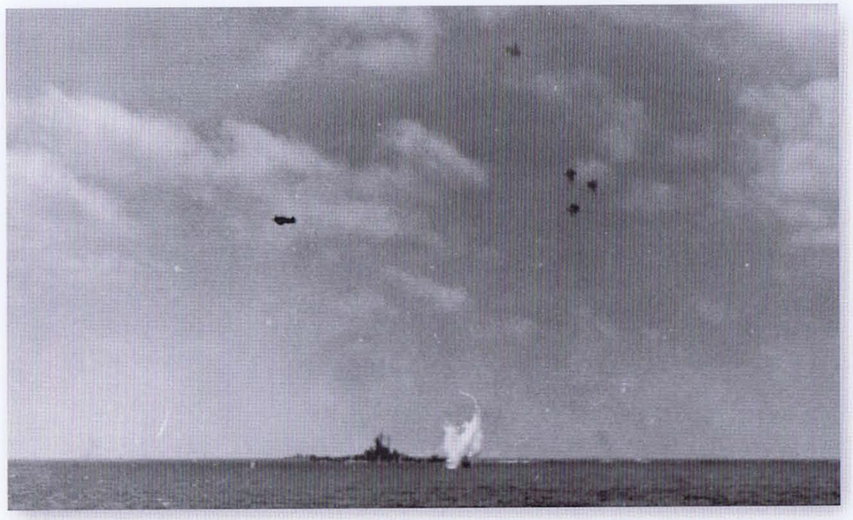
Between 01:00am and 01:02 and 39 seconds, *Washington* fired 39 rounds of 16-inch shells. *Washington* ceased fire for one and a half minutes, and then at 01:04 recommenced for a further three minutes during which she fired 36 rounds of 16-inch shells at *Kirishima*. As important, the turrets were training 20 degrees per minute, from 008 degrees to 148 degrees, in order to stay on target, when the forward turrets hit their stops at 01:07am and *Washington* ceased fire.

Two mounts of *Washington*'s starboard 5-inch guns had also fired at *Kirishima* and two mounts fired at the ships firing on *South Dakota*. The fifth 5-inch mount fired 62 rounds of 5-inch star shells over *Kirishima*.

At 01:05am *Kirishima* turned to port and presented her stern and then port side to *Washington* and was hit on or near her rudder, jamming it. Two minutes later she began steering two complete circles before coming to a stop and sinking several hours later.

As *Kirishima* steamed past *Washington*, Admiral Lee was aware that *South Dakota* was nearing the same bearing as *Kirishima* and her two escorting cruisers. The danger of firing on *South Dakota* made Lee reluctant to maneuver to continue fire.

South Dakota class battleship under air attack.



Washington claimed nine hits from 75 rounds of 16-inch shells fired, an accuracy rate of 12 percent against a target moving on a nearly opposite course with a high rate of deflection needed to account for the passing speed of 54 knots. Additionally, range and bearing were determined by radar. This result attests to the quality of the Ford Instrument Range Keeper, able to accurately determine firing solutions with a rapidly changing bearing and a course correction. US battleship radar negated Japanese night training. Research after the war, including interviews with surviving officers of *Kirishima*, suggests that *Kirishima* suffered 20 hits by 16-inch shells, as many shells falling short but continuing underwater to hit *Kirishima*'s hull. Should this be accurate, *Washington*'s accuracy rate was nearly 27 percent.

As a result of the battle, the bombardment of Henderson Field was cancelled. The troop transports following the Japanese bombardment force continued to Guadalcanal but were caught in daylight by aircraft from Henderson Field and destroyed. Only 2,000 troops survived to reach their colleagues on shore, but without their supplies of food and ammunition.

This battle, won by *Washington*, together with the success of the US Marines in defending Henderson Field, and the devastation of Japanese troop reinforcements by Marine and Navy aircraft, marked the beginning of the US drive toward defeating Japan.

November 1943 saw US forces in control of the Solomon Islands chain. Following *Washington*'s victory over the IJN in November 1942, this ship together with *North Carolina*, *Indiana*, and *Massachusetts* provided protection to the carriers *Saratoga* and HMS *Victorious* in support of the naval and Marine forces fighting their way up the Solomons. HMS *Victorious* was allocated to the South Pacific force while *Enterprise* was having her battle damage repaired.

Central Pacific offensive

On May 30, 1943, USS *Essex* arrived in Pearl Harbor, the first of the new fast carriers. Over the next few months, seven other new fast carriers joined *Essex*, demonstrating the output of America's vast industrial, shipbuilding, and military capability now geared to war. This force, named the Fifth Fleet, together with the Fifth Amphibious Force, six new fast battleships, *North Carolina*, *Washington*, *South Dakota*, *Massachusetts*, *Alabama* and *Indiana*, and four old battleships, was to spearhead the next phase of the Pacific war – the drive across the central Pacific – with the Gilbert Islands the first objective. Admiral Spruance, chief of staff to Admiral Nimitz, was appointed to command the Fifth Fleet.

Operation	**Date**	***North Carolina***	***Washington***	***South Dakota***	***Indiana***	***Massachusetts***	***Alabama***
Gilberts	11/43	√	√	√	√	√	√
Naru	12/43	√	√	√	√	√	√
Kwajalein	1/44	√	√	√	√	√	√
Truk	2/44	√	**X**	**X**	√	√	√
Palau	3/44	√	√	√	**X**	√	√
Hollandia	4/44	√	**X**	√	**X**	√	√
Marianas	6/44	√	√	√	√	**X**	√
Leyte	11/44	√	√	**X**	**X**	√	√
Luzon/China	1/45	√	√	√	**X**	√	**X**
Iwo Jima	2/45	√	√	√	√	√	**X**
Okinawa	3/45	√	√	√	√	**X**	√
Kyushu	7/45	√	√	√	√	√	√
Japan	8/45	√	**X**	√	√	√	√

X The ship did not participate in the operation as she was undergoing repair or refit.

Between November 1943 and August 1945, these six fast battleships took part in the following operations:

The majority of these operations involved multiple actions, from providing AA protection to the carriers to bombarding islands to be invaded by the Marines and Army.

Underpinning these operations were five critical technological or organizational developments:

- Proximity Fuse

  The Radio Proximity Fuse emitted radio waves from the shell in flight. When the waves hit a solid object within a 70-yard radius it detonated the shell. Used against aircraft this new proximity fuse significantly increased the chance of downing the aircraft. First used in action on January 1, 1943 by USS *Helena*, proximity fused 5-inch shells were available to the Fifth Fleet for the Gilberts operation.
- Radar

  Radar had been significantly enhanced and installed across the fleet, and this allowed task forces to maneuver at night and in bad weather with precision. As important, radar could now locate and track low-flying enemy aircraft.
- Fighter direction

  Formalizing radar and VHF communications into an air plot enabled fighter direction operations based upon a standard process, and allowed trained fighter direction officers to be established in all carriers. The RAF fighter direction methods used during the Battle of Britain in 1940 had been adapted and developed by Royal Navy carriers in 1940–41 during operations off Norway and in the Mediterranean. During the assignment of HMS *Victorious* with the US Navy, operating with *Saratoga* in the South Pacific, and her subsequent refitting in the Norfolk Navy Yard, her fighter direction organization, operating procedures, and the new vertical plot were inspected and then adopted by the US Navy, through Admiral King's Washington office.
- The Hellcat

  A new naval fighter aircraft, the Hellcat, specifically designed to beat the Zero, had been introduced to the Fleet.
- Circular formation

  The circular formation was perfected and applied to both task force formation and multiple task force formations. This resulted in multiple

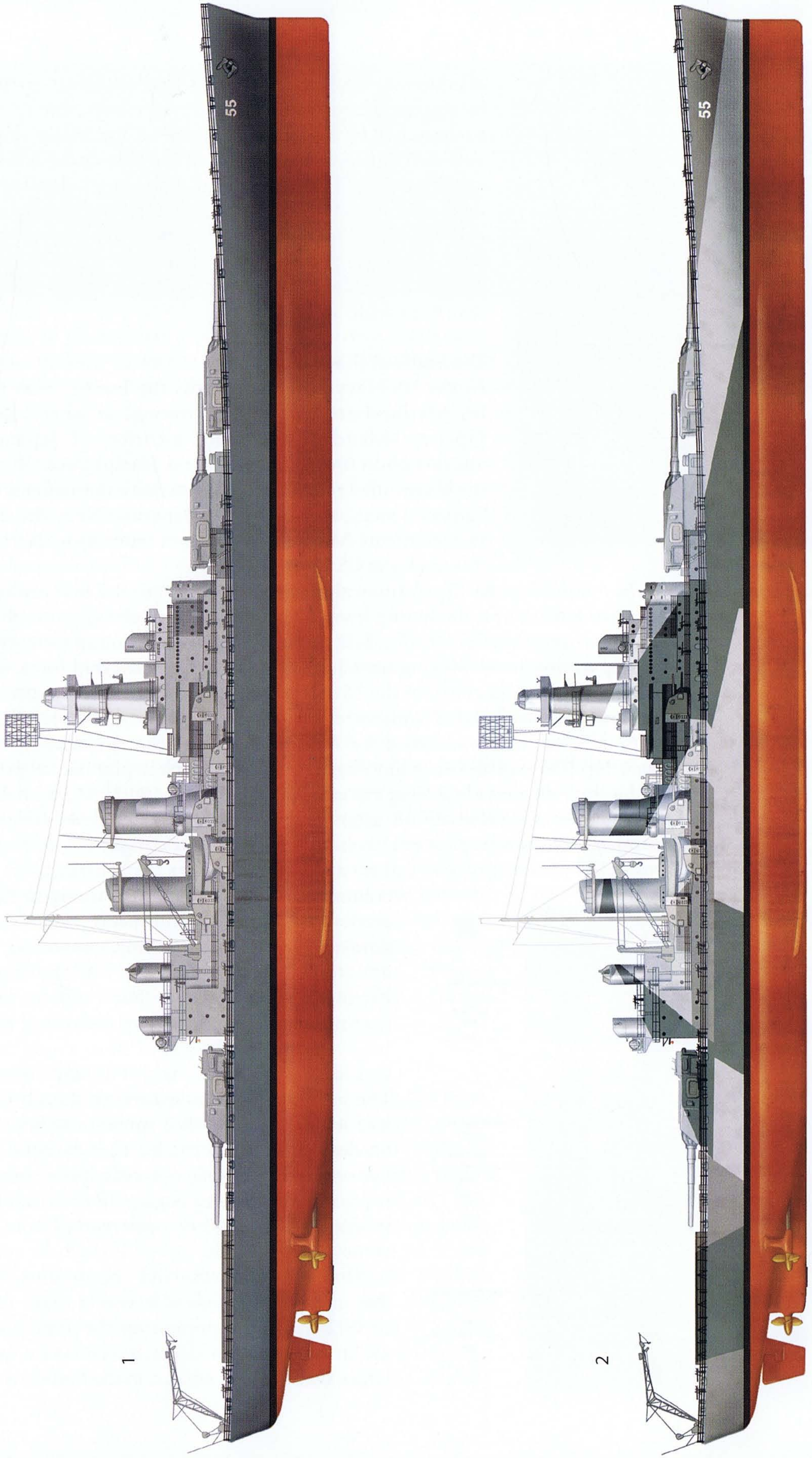
G

CAMOUFLAGE SCHEMES 1941–43

North Carolina had several camouflage schemes during her operational life. The objectives of camouflage were to reduce the visibility of the ship and to create confusion in the eyes of the viewer as to identity, heading, and speed of the ship. Naturally, this varied greatly, depending on the operational requirements. All paints used were matt to minimize the risk of reflection.

1. *North Carolina's* original camouflage scheme was the Measure 2 graded system applied in 1941. This consisted of ocean gray on the hull, haze gray on the superstructure, pale gray on top of the director tower, and deck blue on all decks.

2. The Measure 32 medium pattern system adopted in 1944 was easily the most dramatic of the North Carolina's history. Pale gray, haze gray, and navy blue were applied in polygonal patterns to confuse identity and heading, especially for observing submarines. This pattern was applied to most surface ships serving in the Pacific in 1944–45. Decks and horizontal surfaces remained deck blue.



The *North Carolina* as seen from the fantail of *Washington*.

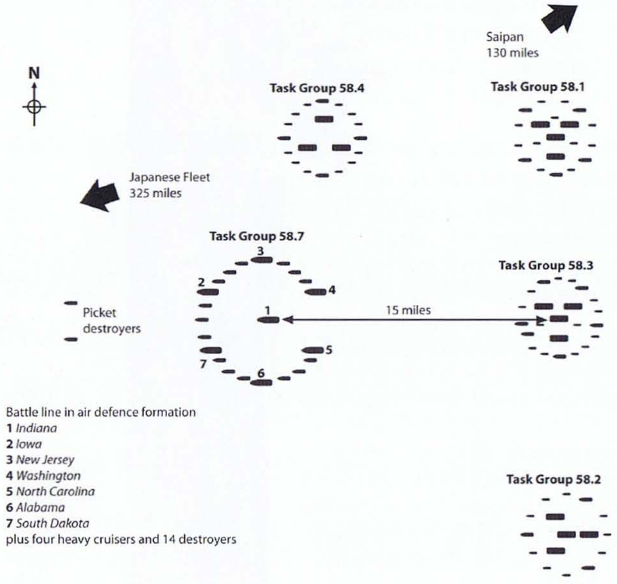
overlapping AA fields of fire. As the number of carriers increased, the formation had the carriers in the center surrounded by concentric circles of escorting ships, with fast battleships stationed in the first circle close in to the carriers. In the event that the Japanese battleship fleet came forward for battle, Admiral Spruance gave Admiral Lee, in command of the fast battleships, permission to form the classic line of battle formation outside the circular formation, with the carriers in the rear to provide air cover.

The battle of the Philippine Sea

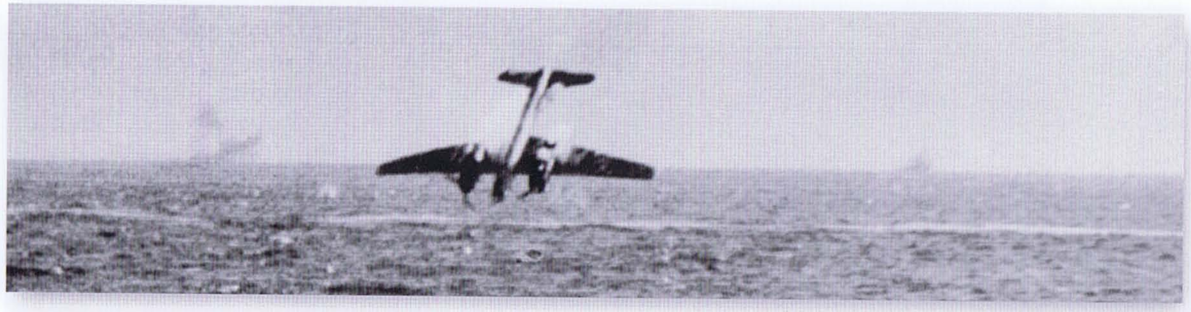
As the US Navy advanced across the Pacific, with the US Marines storming and capturing, at heavy cost, Japanese Islands, the rate of attrition of Japanese aircraft and crews continued at a fearful pace. When the US invaded the Marianas, to acquire the airfields on Saipan, Tinian, and Guam, the Japanese Navy decided to commit its Mobile Fleet of nine remaining carriers to attack the US Fifth Fleet.

In organizing the fleet, Admiral Spruance had Admiral Lee withdraw his fast battleships, including two of the new Iowa class, from their AA escort positions to form his fast battleship circular steaming formation in preparation for deploying into line of battle. Lee's battleship force was positioned 15 miles ahead of the 15 carriers in four separate circular carrier formations. Lee headed westward to locate and destroy the Japanese Mobile Fleet. Lee was asked by Admiral Mitscher, commander of the carriers, "Do you desire night engagement?" Mitscher planned a strike by his carrier aircraft during the afternoon of June 18, 1944, with Lee engaging in a surface action after the air strike. Lee signaled Mitscher in reply, "Do not (repeat not) believe we should seek night engagement. Possible advantages of radar more than offset by difficulties of communication and lack of training in fleet tactics at night. Would press pursuit of damaged or fleeing enemy, however, at any time." Lee's experience in the night battle of Guadalcanal had shown him that notwithstanding having radar and talk between ship radios, confusion could and would easily arise with deadly effect. The prolonged role as escorts to the carriers had left no time for Lee to exercise his fast battleships in night battle. This decision by Lee negated one of the two real opportunities for fast battleships to engage IJN battleships in combat. The other opportunity was to come at Leyte Gulf.

US formation at the battle of the Philippine Sea.



Coming towards the battleships on the morning of June 19 was an air raid of 202 aircraft representing the first wave of Japanese carrier aircraft. This raid was larger than the 183 aircraft in the first wave of Japanese planes that attacked Pearl Harbor. *Alabama* was the first ship to locate the aircraft on her radar at a range of 140 miles at 9:57am. At 10:19am the order was given to the carriers to launch their Combat Air Patrols (CAP), and 220 Hellcats took off and began to head west to meet the incoming Japanese aircraft. The Hellcats met the raid at 10:25am, approximately 54 miles west of the task force and began to destroy it.



A Japanese Betty bomber about to splash.

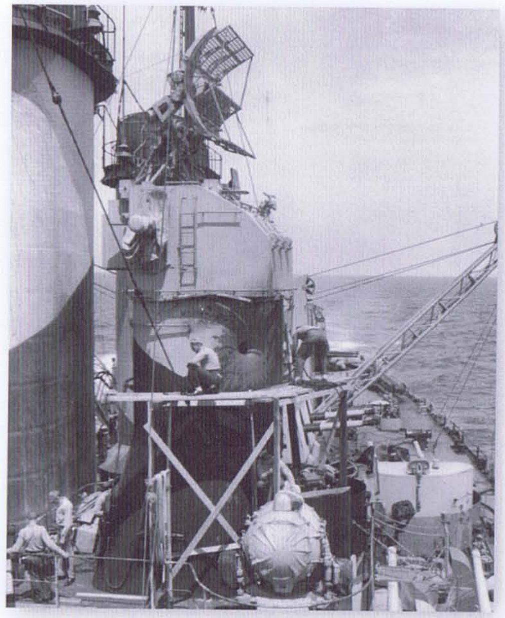
By 10:48am the massive dogfight of milling aircraft had reached the battleship formation, and Lee's ships put up a barrage of AA fire. The CAP, together with the volume of battleship AA fire, prevented any large air attack being made against Lee's battleships, or continuing through to the carriers. *Indiana* had the first success in downing an aircraft, but at 10:49am *South Dakota* suffered a direct hit from a 500lb bomb on the port side of her superstructure, killing 24 and wounding 27. By 10:57am the air-sea battle was over, but a second wave of 128 Japanese aircraft was heading toward the fleet.

Between 11:50am and 12:15am, dive and torpedo bombers attacked Lee's battleships, but the volume of AA fire prevented any aircraft from completing their attack. At 12:14pm, *Indiana* had a Japanese torpedo plane crash into and bounce off its starboard quarter at the waterline which dented, but did not rupture, the outer plating of the ship's hull. *Indiana* shot down five aircraft. Fast battleships accounted for nine aircraft downed in what came to be known as the "Marianas Turkey shoot" as Japan lost 244 carrier aircraft. The combination of the Hellcat, aggressive fighter pilots, and excellent vectoring by fighter direction resulted in an overwhelming victory for the Fifth Fleet. However, six of the nine Japanese carriers survived the battle and were to play a critical role in the battle of Leyte Gulf.

South China Sea

During the night of January 10, 1945, *North Carolina*, *Washington*, *South Dakota*, and *Massachusetts*, as part of Admiral Halsey's Third Fleet, steamed into the South China Sea, the heart of Japan's supply route from the oil fields of South Asia to Japan. US submarines had practically cut this route, so that the remaining heavy units of the IJN had to be stationed near the oil source rather than in Japanese harbors. Admiral Halsey's objectives were to seek out the IJN, sink merchant shipping, and destroy aircraft located on the Indo and South China coast and Formosa (modern Taiwan). By the time Halsey's fleet reached the IJN anchorage at Camranh

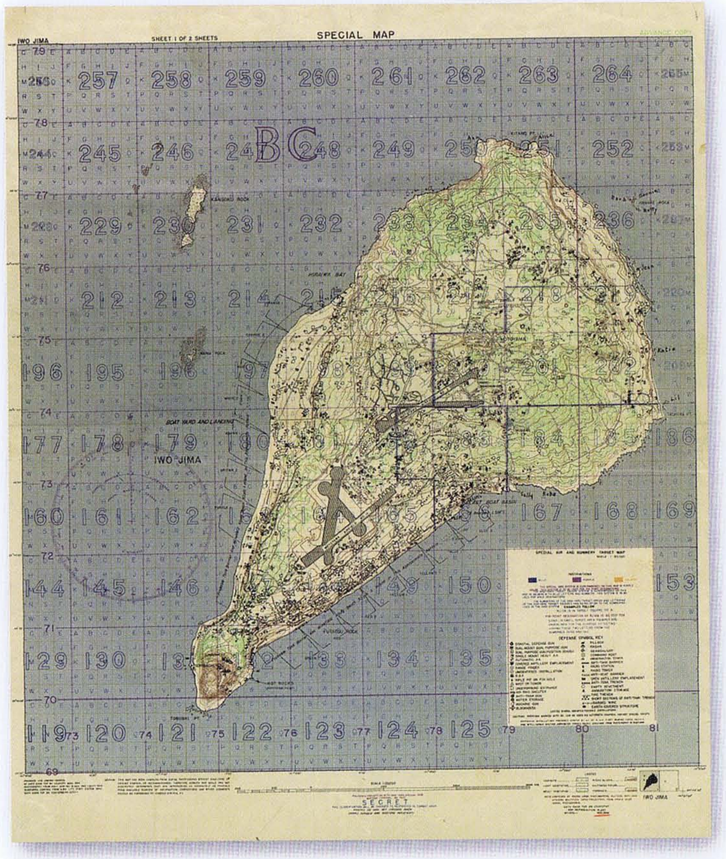
Damage to the port secondary battery director caused by friendly fire.



Bay, the IJN ships had withdrawn to Singapore. Aircraft from the Third Fleet destroyed over 100 aircraft along the Indo-China coast, Hainan, Formosa, and Hong Kong. Twelve oil tankers were sunk plus 32 other merchant ships and two IJN vessels. During this operation, the fast battleships refueled destroyers two at a time. The Third Fleet returned to the Pacific on January 20 without sustaining any damage.

Shore bombardment

Fast battleships were used for pre-invasion bombardment of Japanese-held Pacific Islands, with the carriers providing air cover. In a number of instances, Saipan, Tinian, and Iwo Jima, the shore bombardment was a significant disappointment, as many targets were not destroyed. The accuracy required to hit pill-boxes defending beaches and command posts was almost impossible to achieve given the trajectory of 16-inch shells.



The gunnery target map for the bombardment of Iwo Jima.

Shore bombardment required a different approach to ship-vs-ship gunfire. Main plot, the ship's navigator, and the crew of the Kingfisher spotting aircraft required an accurate navigational chart showing the ship's planned track and the target area on land. The target area was overlaid with a grid and numbered to provide coordinates in order to fix a target's position, which included its elevation above sea level. The ship had to be navigated precisely, allowing for current and wind effect on the ship's position, which then had to be determined every few minutes. The range and bearing to the target was calculated on the chart, and provided the input for the Range Keeper, rather than from the directors and radar plot. This system did not allow for rapid and continuous fire. However, against large industrial plants near

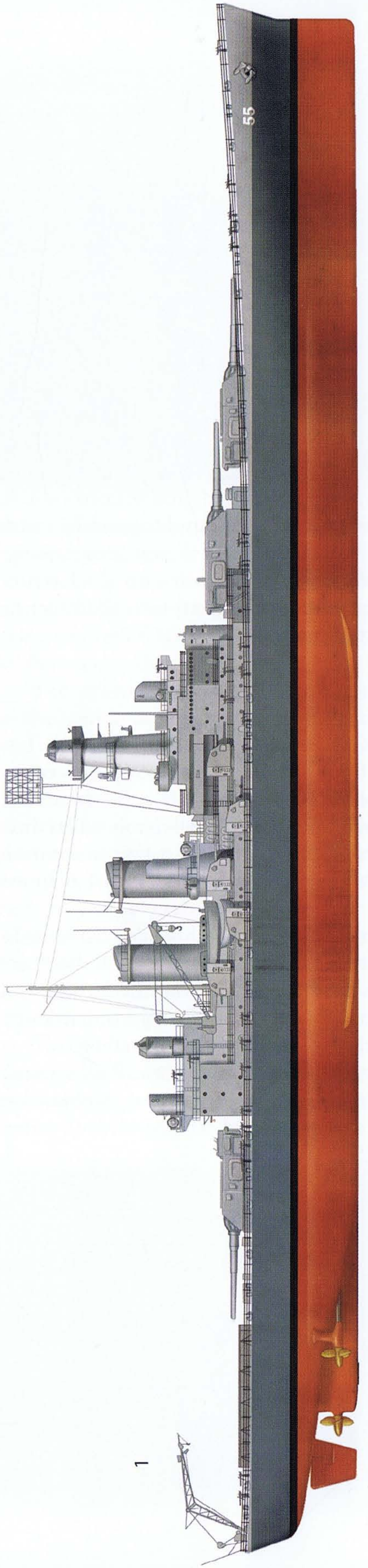
H

CAMOUFLAGE SCHEMES 1944–47

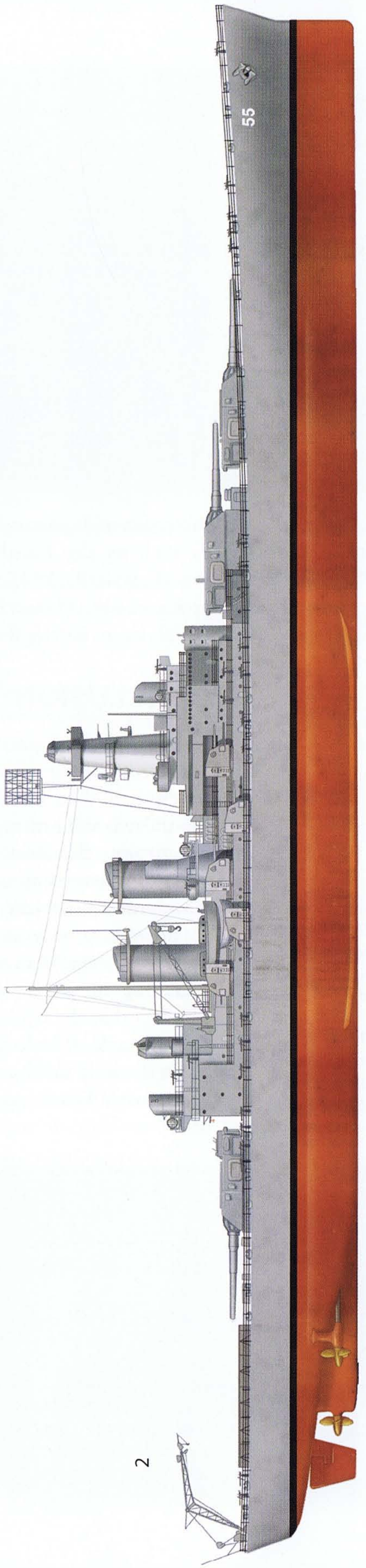
Towards the end of the war, the *North Carolina* underwent further changes to her camouflage scheme.

1. Designed to fool surface observers with the impression of greater distance provided by its false horizon effect, the Measure 22 graded system was widely applied to US Navy vessels in the Atlantic and European coastal waters from late 1942, and in the Pacific from late 1944. *North Carolina* bore this pattern from 1945 to 1946. The scheme comprised navy blue on the hull horizontal to the lower point of sheer, haze gray on all vertical surfaces above this point, and deck blue on all decks.

2. In 1947, the *North Carolina* adopted the Measure 13 haze gray system, which saw the ship repainted entirely in haze gray, save for the traditional deck blue, which was used on all decking. This pattern was thought to provide reasonable protection under a variety of situations, and was adopted widely by ships in the post-war years.



1



2

Washington leads *North Carolina*, and *South Dakota* as they follow USS *Ticonderoga* in the South China Sea, January 1945.

the coast of Japan, which could be spotted by director and located by radar as well as the bombardment chart, battleship gunfire was devastating. On August 9, 1945, firing on and destroying the iron and steel center at Kamaishi, *Massachusetts*, which had fired the first 16-inch shell for the US Navy in World War II, fired the last 16-inch shell of that war.

CONCLUSION

The loss of the pre-1922 battleships at Pearl Harbor put the new fast battleships along with carriers into the front line of the Pacific war. It is ironic that the role of fast battleships in the Pacific, as part of fast carrier task forces, was the one rejected by the General Board of the US Navy when their design was finalized. As fast battleships, the North Carolina and South Dakota class were not fast enough, with a top speed deficit of 6 knots compared to carriers.

However, the secondary armament of quick-firing, high-angle 20 5-inch/38 guns and range were powerful enough to break up dive and torpedo bombers attacking carriers, even as the carriers steamed away from the battleships. The fact that the US Navy did not lose one carrier escorted by a fast battleship to air attack, after losing three unescorted by October 1942, is telling.

In the only fast battleship versus fast battleship action at sea, *Washington*'s battle with *Kirishima* showed the destructive capability of the combination of 16-inch guns and armor-piercing shells married to fire-control radar, the Ford Range Keeper, directors, and a highly trained crew. Firing 75 shells in five and a half minutes at *Kirishima*, which was approaching on an opposing course, with *Washington*'s gun turrets training at 20 degrees per minute, a closing speed of 54 knots, with a rapid change of course by *Kirishima*, all at night and achieving a minimum accuracy rate of 12 percent, makes this action by *Washington* the most effective example of accurate battleship gunfire in battleship history for the period 1905–45.

BELOW
Massachusetts leads *South Dakota* and *Indiana* and a heavy cruiser prior to bombarding the Iron Works at Kamaishi, Honshu, in July 1945.

BELOW RIGHT
North Carolina bombards the Japanese mainland. Three 16-inch shells can be seen in the upper left of the picture.

War's end, homeward bound. *North Carolina* transits the Panama Canal, October 1945.

In addition to the fast battleships' strong main and AA armament, their fuel and stores capacity, cruising range, and ability to refuel destroyers multiplied their lethal capability. From their entry into the Atlantic and Pacific theaters until the end of the war, these ships were able to sustain a high level of operational performance, demonstrating the quality of their machinery and equipment, together with the operating efficiency and stamina of their crews.

The only demonstrated vulnerability of fast battleships was the command and control structure of the bridge and superstructure tower, located above the armored deck, as shown by *South Dakota* during the night battle of Guadalcanal.

The unanswered question regarding these ships is how they would have performed in action against the *Musashi* and *Yamato*, when on the receiving end of 18-inch shells. Fortunately, the bravery and skill of US carrier aircrews makes this question purely academic.

The battles of the Eastern Solomons and Santa Cruz during the Guadalcanal campaign, involving the *North Carolina* and *South Dakota* respectively, established a new primary role for the six battleships as close-in escorts to US fast carriers. This melding of mutually supporting ships into task forces, whereby no carriers nor battleships escorting each other were sunk by enemy bombs or torpedoes, created a new weapon system for the US Navy which then drove across the Pacific from Pearl Harbor to Tokyo Bay and took care of the Kongo fast battleships as well as the *Musashi* and *Yamato* in the process.

Three fast battleships, the *North Carolina*, *Alabama*, and *Massachusetts*, have survived as memorials and museums, so it is still possible to walk along the sweeping weather deck from bow to stern, climb into a 16-inch gun turret and grip the trigger mechanism, wander through a maze of compartments,

North Carolina and *Washington* in formation during the summer midshipman cruise from Annapolis.

Battleship *North Carolina* today as a museum in Wilmington, North Carolina.

twirl the handles on the Ford Range Keeper, study a radar plot, look at an amazing range of dials and levers in a machinery room, hold the helm in the conning tower behind 16 inches of armor, look into a 5-inch gun turret, sit behind a 40mm Bofors gun and then stand behind a 20mm gun on an open deck and gaze out and imagine an attacking aircraft.

BIBLIOGRAPHY

Books

There is a wealth of books on battleships and the naval war in the Pacific. The author found the following to be helpful:

Blee, Captain Ben, USN, *Battleship North Carolina* (Battleship North Carolina)

Felker, Craig C., *Testing American Sea Power: US Navy Strategic Exercises, 1923–1940*

Friedman, Norman, *US Battleships* (Naval Institute Press)

Friedman, Norman, *Naval Firepower* (Naval Institute Press)

Garzke/Dulin, *Battleships: United States Battleships 1935–1992* (Naval Institute Press)

Glover, Admiral Cato D., USN, *Command Performance with Guts* (Greenwich Book Publishers)

Kuehn, John T., *Agents of Innovation: The General Board and the Design of the Fleet that Defeated the Japanese Navy* (Naval Institute Press)

Naval Historical Center, *Operational Experience of Fast Battleships* (Department of the Navy)

Smith, Douglas V., *Carrier Battles: Command Decisions in Harm's Way* (Naval Institute Press)

Wildenberg, Thomas, *All the Factors of Victory* (Brassey's Inc)

Internet

www.battleshipnc.com
www.ussalabama.com
www.battleshipcove.org/bb59-history.htm
www.hnsa.org

APPENDICES

North Carolina class

	***North Carolina* (BB-55)**	***Washington* (BB-56)**
Builder	New York Navy Yard, Brooklyn, NY	Philadelphia Navy Yard, Philadelphia, PA
Laid down	October 27, 1937	June 14, 1938
Launched	June 13, 1940	June 1, 1940
Commissioned	April 9, 1941	May 15, 1941
Disposition	Dedicated as a war memorial at Wilmington, NC, on October 3, 1961	Scrapped 1961
Displacement	(1942) 36,600 tons Standard, 44,800 tons Full load (1945) 46,700 tons Full load	(1942) 36,600 tons Standard, 44,800 tons Full load (1945) 45,370 tons Full load
Dimensions	728′8″ Length overall 713′5″ Waterline length 108′3″ Maximum beam 104′6″ Waterline beam 31′7″ Mean draft 35′6″ Maximum draft	728′11″Length overall 713′8″ Waterline length 108′3″ Maximum beam 104′6″ Waterline beam 31′8″ Mean draft 34′9″ Maximum draft
Armament		
Main	Nine 16-inch/45 caliber guns (Mark 6)	Nine 16-inch/45 caliber guns (Mark 6)
Secondary	Twenty 5-inch/38 caliber guns (Mark 12)	Twenty 5-inch/38 caliber guns (Mark 12)
Anti-aircraft	40mm 1.1″ 20mm .50 cal Apr 1941 none 16 none 12 Dec 1941 none 16 40 12 June 1942 none 16 40 28 Dec 1944 60 none 48 none June 1945 60 none 36 none	40mm 1.1″ 20mm .50 cal Apr 1941 none 16 none 12 Dec 1941 none 16 20 12 June 1942 none 16 20 28 Dec 1944 60 none 67 none Aug 1945 60 none 83 none Nov 1945 60 none 63 none
Armor		
Belt armor	12″ inclined 15° Tapered to 6.6″	12″ inclined 15° Tapered to 6.6″
Deck armor		
Main	1.45″	1.45″
Second	1.4″ + 3.6″	1.4″ + 3.6″
Third	0.62″	0.62″
Total	**7.07″**	**7.07″**
Barbette armor		
Centerline forward	14.7″	14.7″
Sides	16.0″	16.0″
Centerline aft	11.5″	11.5″
Turret armor		
Face plates	16.0″	16.0″
Sides	9.8″	9.8″
Back plates	11.8″	11.8″
Roof plates	7.0″	7.0″
Secondary gun armor		
Gun mounts	1.95″	1.95″
Magazines	1.95″	1.95″
Conning tower armor		
Centerline sides	14.7″	14.7″
Beam sides	16.0″	16.0″
Roof plates	7.0″	7.0″
Comm. tube	14.0″	14.0″
Machinery		
Boiler	Eight Babcock & Wilcox three drum boilers fitted with two furnaces and double uptakes. Pressure: 575 psi. Temperature: 850°F	Eight Babcock & Wilcox three drum boilers fitted with two furnaces and double uptakes. Pressure: 575 psi. Temperature: 850°F
Turbines	Four sets General Electric geared turbines High pressure impulse turbines – 12 stages, 5,904 rpm maximum Low pressure impulse turbines – 6 stages, 4,937 rpm maximum Astern impulse turbines – 3 stages, 3,299 rpm maximum	Four sets General Electric geared turbines High pressure impulse turbines – 12 stages, 5,904 rpm maximum Low pressure impulse turbines – 6 stages, 4,937 rpm maximum Astern impulse turbines – 3 stages, 3,299 rpm maximum
Shaft horsepower	121,000 (32,000 astern)	121,000 (32,000 astern)
Maximum speed	28.0 knots @ 199 rpm and 121,000 shp – 1941 26.8 knots – 1945	28.0 knots @ 199 rpm and 121,000 shp – 1941 26.8 knots – 1945
Nominal endurance	17,450 nautical miles @ 15 knots – 1941 16,320 nautical miles @ 15 knots – 1945 5,740 nautical miles @ 25 knots – 1945	17,450 nautical miles @ 15 knots – 1941 16,320 nautical miles @ 15 knots – 1945 5,740 nautical miles @ 25 knots – 1945
Generators	Four ship's service turbogenerators (1.250kw) Four ship's service diesel generators (850kw) Two emergency diesel generators (200kw)	Four ship's service turbogenerators (1.250kw) Four ship's service diesel generators (850kw) Two emergency diesel generators (200kw)

South Dakota class

	South Dakota (BB-57)	*Indiana* (BB-58)
Builder	New York Shipbuilding Corp., Camden, NJ	Newport News Shipbuilding & Dry Dock Co., Newport News, VA
Laid down	July 5, 1939	November 20, 1939
Launched	June 7, 1941	November 21, 1941
Commissioned	March 20, 1942	April 30, 1942
Disposition	Scrapped 1962 Parts to South Dakota for war memorial	Scrapped 1961
Displacement	(1942) 38,664 tons Standard 44,519 tons Full load (1945) 38,506 tons Standard 46,200 tons Full load	(1942) 44,374 tons Full load (1945) 35,900 tons Standard 44,600 tons Full load
Dimensions	680′4″ Length overall 666′0″ Waterline length 108′1″ Maximum beam 27′9″ Mean draft 36′4″ Maximum draft	680′0″ Length overall 666′0″ Waterline length 108′2″ Maximum beam 27′9″ Mean draft 36′2″ Maximum draft
Armament		
Main	Nine 16-inch/45 caliber guns (Mark 6)	Nine 16-inch/45 caliber guns (Mark 6)
Secondary	Sixteen 5-inch/38 caliber guns (Mark 12)	Twenty 5-inch/38 caliber guns (Mark 12)
Anti-aircraft	40mm 1.1″ 20mm .50 cal Mar 1942 none 28 16 8 Sept 1942 16 20 36 none Feb 1943 68 none 35 none Dec 1944 68 none 72 none Mar 1945 68 none 77 none	40mm 1.1″ 20mm .50 cal June 1942 24 none 16 none Dec 1944 48 none 55 none Dec 1945 48 none 52 none
Armor		
Belt armor	12.2″ inclined 19°	12.2″ inclined 19°
Lower belt armor	12.2″ tapered to 1.0″	12.2″ tapered to 1.0″
Deck armor		
Main	1.5″	1.5″
Second	5.0″ + 0.75″	5.0″ + 0.75″
Splinter	0.625″	0.625″
Third	0.3″	0.3″
Total	**8.175″**	**8.175″**
Barbette armor		
Centerline	11.6″	11.6″
Sides	17.3″	17.3″
Turret armor		
Face plates	18.0″	18.0″
Sides	9.5″	9.5″
Back plates	12.0″	12.0″
Roof plates	7.25″	7.25″
Secondary gun armor		
Gun mounts	2.0″	2.0″
Magazines	2.0″	2.0″
Conning tower armor		
Sides	16.0″	16.0″
Roof plates	7.25″	7.25″
Bottom plates	4.0″	4.0″
Comm. tube	16.0″	16.0″
Machinery		
Boiler	Eight Babcock & Wilcox three drum boilers fitted with two furnaces and double uptakes Pressure: 578 psi Temperature: 850°F	Eight Foster Wheeler three drum boilers fitted with two furnaces and double uptakes Pressure: 578 psi Temperature: 850°F
Turbines	Four sets General Electric geared turbines	Four sets Westinghouse geared turbines
Shaft horsepower	130,000 (32,000 astern)	130,000 (32,000 astern)
Maximum speed	27.8 knots @ 185 rpm – 1941 27.0 knots – 1945	27.8 knots @ 185 rpm – 1941 27.0 knots – 1945
Nominal endurance	17,000 nautical miles @ 15 knots – 1945 6,400 nautical miles @ 25 knots – 1945	17,000 nautical miles @ 15 knots – 1945 6,400 nautical miles @ 25 knots – 1945
Generators	Seven ship's service turbogenerators (1,000kw) Two emergency diesel generators (200kw)	Seven ship's service turbogenerators (1,000kw) Two emergency diesel generators (200kw)

	Massachusetts (BB-59)	*Alabama* (BB-60)
Builder	Bethlehem Steel Co., Quincy, MA	Norfolk Navy Yard, Portsmouth, VA
Laid down	July 20, 1939	February 1, 1940
Launched	September 23, 1941	February 16, 1942
Commissioned	May 12, 1942	August 16, 1942
Disposition	Dedicated as a war memorial at Fall River, MA, on June 12, 1965	Dedicated as a war memorial at Mobile, AL, in 1964
Displacement	(1942) 45,216 tons Full load (1945) 38,988 tons Standard 46,314 tons Full load	(1942) 44,800 tons Full load
Dimensions	680′9″ Length overall 666′0″ Waterline length 108′2″ Maximum beam 28′7″ Mean draft 36′9″ Maximum draft	679′5″ Length overall 666′0″ Waterline length 108′1″ Maximum beam 28′4″ Mean draft 36′2″ Maximum draft
Armament		
Main	Nine 16-inch/45 caliber guns (Mark 6)	Nine 16-inch/45 caliber guns (Mark 6)
Secondary	Twenty 5-inch/38 caliber guns (Mark 12)	Twenty 5-inch/38 caliber guns (Mark 12)
Anti-aircraft	40mm 1.1″ 20mm .50 cal May 1942 24 none 35 none Dec 1944 72 none 38 none June 1945 72 none 33 none Nov 1945 72 none 41 none	40mm 1.1″ 20mm .50 cal Aug 1942 24 none 22 none Dec 1944 48 none 52 none Feb 1945 48 none 56 none Nov 1945 48 none 52 none
Armor		
Belt armor	12.2″ inclined 19°	12.2″ inclined 19°
Lower belt armor	12.2″ tapered to 1.0″	12.2″ tapered to 1.0″
Deck armor		
Main	1.5″	1.5″
Second	5.0″ + 0.75″	5.0″ + 0.75″
Splinter	0.625″	0.625″
Third	0.3″	0.3″
Total	**8.175″**	**8.175″**
Barbette armor		
Centerline	11.6″	11.6″
Sides	17.3″	17.3″
Turret armor		
Face plates	18.0″	18.0″
Sides	9.5″	9.5″
Back plates	12.0″	12.0″
Roof plates	7.25″	7.25″
Secondary gun armor		
Gun mounts	2.0″	2.0″
Magazines	2.0″	2.0″
Conning tower armor		
Sides	16.0″	16.0″
Roof plates	7.25″	7.25″
Bottom plates	4.0″	4.0″
Comm. tube	16.0″	16.0″
Machinery		
Boiler	Eight Babcock & Wilcox three drum boilers fitted with two furnaces and double uptakes Pressure: 578 psi Temperature: 850°F	Eight Foster Wheeler three drum boilers fitted with two furnaces and double uptakes Pressure: 578 psi Temperature: 850°F
Turbines	Four sets General Electric geared turbines	Four sets Westinghouse geared turbines
Shaft horsepower	130,000 (32,000 astern)	130,000 (32,000 astern)
Maximum speed	27.8 knots @ 185 rpm – 1941 27.0 knots – 1945	27.8 knots @ 185 rpm – 1941 27.0 knots – 1945
Nominal endurance	17,000 nautical miles @ 15 knots – 1945 6,400 nautical miles @ 25 knots – 1945	17,000 nautical miles @ 15 knots – 1945 6,400 nautical miles @ 25 knots – 1945
Generators	Seven ship's service turbogenerators (1,000kw) Two emergency diesel generators (200kw)	Seven ship's service turbogenerators (1,000kw) Two emergency diesel generators (200kw)

INDEX

Note: letters in **bold** refer to plates and illustrations.

aircraft attack vulnerability 15–16, 17
Alabama, USS 12, 17, 35; Philippine Sea Battle 39; specifications 47
anti-aircraft (AA) armament 36, 44; Bofors (40mm) 8, 14, 23, 26, 44; 1.1-inch 8, **14**, 22, 26; 20mm 16, 22, 24, **31**, **34**, 43, 44
Ark Royal, HMS 15
armor protection 8, 10, 11
Atago, IJN **F32–3**
Atlanta, USS 19
Atlantic operations 16–17
Ayanami, IJN 31

Badger, Capt 16
Benham, USS 31
Bismarck, KM 15

California, USS 18
camouflage, *North Carolina* **G36–7**, **H40–1**
Casablanca, action off (1942) 16–17
Central Pacific offensive 35–8
circular protective formations 17–18, **22**, 36–8, **38**
Coral Sea, Battle of (1943) 17, 23, 36

Dauntless dive-bombers **30**

Eastern Solomons, Battle of (1942) 8, 19–24, **23**, **24**, **D24–5**, 28, 43
Enterprise, USS 26, 27; Eastern Solomons Battle 19–22, **23**, 24, **24**; Santa Cruz Battle 27–8; ‘seven minutes of hell’ **D24–5**
Essex, USS 35

fighter direction control 36, 39
fire-control radar 12–14, 16, 18, **C20–1**, 42–3; during Guadalcanal battle 30, 31, 32–5
fire-control directors, Mark 37/38 12, 14, **C20–1**, **39**
Fisher, Adm 8
Fiske, Lt 12
‘Fleet Problem Exercises’ 7; IX (1929) 8
Fletcher, Adm 18, 19, 23
Formidable, HMS 15
Fort, Capt 23
Fougeux, French destroyer 17
Furious, HMS 8

Gatch, Capt 27
Ghormley, Adm 30
Guadalcanal 18–19, 27, 35; reinforcements 22–3; ‘The Tokyo Express’ 30 *see also* Henderson Field
Guadalcanal night battle (1942) 12, 28–35, **F32–3**, 38
Gwin, USS 31

Halsay, Adm 30, 39
handling space (magazine-powder rooms) **17**
Haruna, IJN 8, 27
Helena, USS 36
Hellcat, fighter aircraft 36, 39
Henderson Field, Guadalcanal 19, 23, 27, 28–30, 32, 35
Hiei, IJN 8, 27, 30
Hornet, USS 26, 27–8

Illustrious, HMS 15
Indiana, USS 12, 35, **42**; Philippine Sea Battle 39; specifications 46
Iwo Jima 35; gunnery map **40**

Jean Bart, French battleship 16–17
Jellicoe, Adm 17
Junyo, IJN 27
Jutland, Battle of (1916) 6, 17

Kanji, Adm Kato 7
King George V, HMS 16
Kingfisher, OS2U Vought Sikorsky 14–15, 16, **19**, **C20–1**, 32, 40
Kinkaid, Adm 22, 23, 24
Kirishima, IJN 8, 32–5, **F32–3**, 42–3
Kirkpatrick, Lt Com 18, 23
Kongo, IJN 8
Kongo class battleships 4, 8, 10

Langley, USS 18
Le Milan, French destroyer 17
Lee, Adm Willis “Ching” 26–7, 30–1, 32, 38
Leyte Gulf, Battle of (1944) 38
London Naval Treaty (1930/36) 4, 7, 10
‘Long Lance’ torpedos 30

Maas, Col M.J. 18–19
MacFall, Com 17
Mahan, USS 12
main armament, guns and turrets; 8-inch 5, 32; 12-inch 7; 14 inch 10, 32; 16-inch 4, 5, 7, 10, **10**, 11, **11**, **18**, **C20–1**, 27, **E28–9**, 40, 42; 16-inch shells **18**; 18- inch 43
Manila Bay, Battle of (1898) 12
Mariana Islands 6, 35, 38
Massachusetts, USS 12, 35, **42**, 43–4; action off Casablanca 16–17; main armament 42; South China Sea Operation 39–40; specifications 47
Midway, Battle of (1942) 17, 18, 23, 36
Mitscher, Adm 38
motor torpedo boats (MTBs) 30, 31
Musashi, IJN 43

Nimitz, Adm 17, 18, 23, 35
North Carolina, USS 5, **6**, **A8–9**, 10, 14, **15**, 16, 17, 18, **19**, **C20–1**, **30**, **31**, **34**, 35, **38**, **42**, **43**, 43–4, **44**; AA guns **14**, 16; boilers 5, **6**; camouflage schemes **G36–7**, **H40–1**; Eastern Solomons Battle 19–24, **23**; ‘seven minutes of hell’ **D24–5**; South China Sea Operation 39–40; specifications 45; torpedo attack 24–6, **27**, **28**
North Carolina class 12, **C20–1**, 42; design and construction 7–11; propellers **7**; specifications 45; vibration problems 10–11

O’Brien, USS 24, 26
Oregon, USS 16

Pacific Operations 17–18
Panama Canal 4, 10
Pearl Habor 17, 18; attack 15, 39, 42
Philippine Sea, Battle of (1944) 12, 38–9
plotting rooms **16**
Portland, USS 19
pre-1922 battleships 5, 6, 42
Preston, USS 31, 32
Primauguet French destroyer 17
Prince of Wales, HMS 15
Proximity Fuse, Radio 36
Punjabi, HMS 16

Radar CXAM **A8–9**, 14, **14**, 22, 36, 38 Guadalcanal night battle 30, 31, 32–5; *North Carolina* **C20–1**
Range Keepers, Ford Instrument Mark 8 12, **15**, 34, 40, 43, 44
Reeves, Adm 8
Repulse, HMS 15
Ryujo, IJN 19

Santa Cruz, Battle of (1942) 12, 27–8, 43
Santiago, Battle of (1898) 16
Saratoga, USS 8, 18, 19, 35, 36
Scapa Flow 16, 17
Scheer, Adm 5–6
secondary armament, dual-purpose 5-inch/38 7, 10, 11, 14, 18, 22, **22**, **26**, 31; *North Carolina* **A8–9**, **C20–1**
Sendai, IJN 31
Shokaku, IJN 19, 27
shore bombardment 40–2
Sky Control air defense 18, **C20–1**, 22, 24
South China Sea Operation (1945) 39–40
South Dakota, USS 17, 35, **42**; Guadalcanal Battle 30–5, **F32–3**, 43; Philippine Sea Battle 39; Santa Cruz Battle 27–8; South China Sea Operation (1945) 39–40; specifications 46;
South Dakota class battleships 11–15, **34**, 42; armor protection 12; boilers and turbines 11; propeller shaft 11–12; secondary armament 12; specifications 46–7; top speed 11; underwater shell hits 11
speed, battleship 8, 10, 11, 42
spotting incoming aircraft **23**
Spruance, Adm 35, 38
Stryker, Com 23–4
‘Stryker’s Bridge’ 8, 26
submarine I-19, IJN 24, **26**

Takao, IJN **F32–3**
Ticonderoga, USS **42**
Tirpitz, KM 16, 17
‘Tokyo Express, The’ 30
Trout, USS 30
turbines and high-pressure boilers 5, **6**, **7**, 10

Vestal, USS 26
Victorious, HMS 35, 36

Walke, USS 31, 32
Washington, USS 10, 16, 26–7, **F32–3**, **38**, **42**, **43**, 43–4; Guadalcanal night battle 30–5, 42–3; main armament 34, 35; South China Sea Operation 39–40; specifications 45;
Washington Naval Treaty (1922) 4–7, 8–10
Wasp, USS 24, 26
West Virginia, USS 7

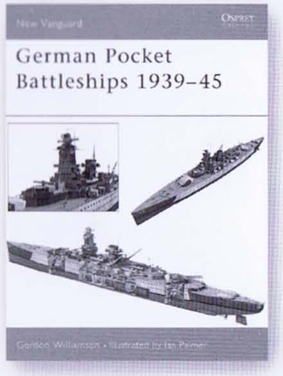
Yamato, IJN 43

Zuiho, IJN 27
Zuikaku, IJN 19, 27

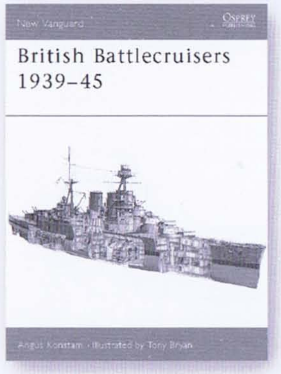
RELATED TITLES

German Battleships 1939–45

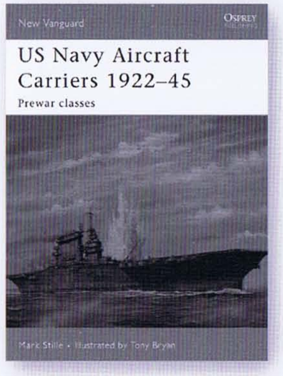
NVG 071 ▪ 978 1 84176 498 6


German Pocket Battleships 1939–45

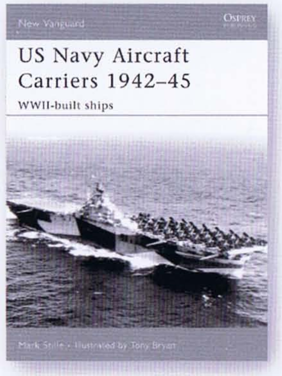
NVG 075 ▪ 978 1 84176 501 3


British Battlecruisers 1939–45

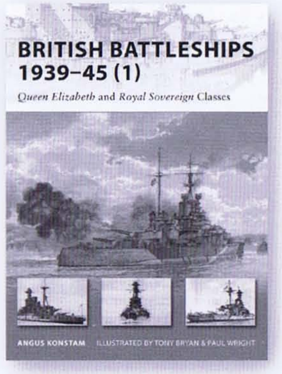
NVG 088 ▪ 978 1 84176 633 1


US Navy Aircraft Carriers 1922–45
Prewar classes

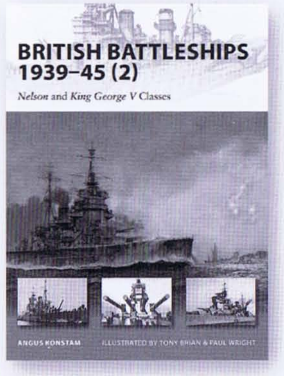
NVG 114 ▪ 978 1 84176 890 8


US Navy Aircraft Carriers 1942–45
WWII-built ships

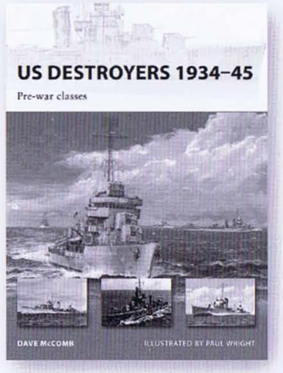
NVG 130 ▪ 978 1 84603 037 6


BRITISH BATTLESHIPS 1939–45 (1)
Queen Elizabeth and *Royal Sovereign* Classes

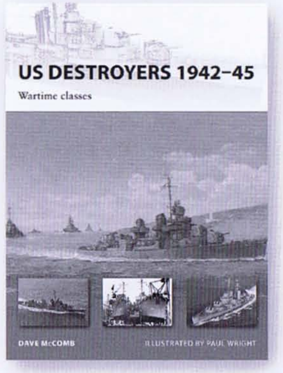
NVG 154 ▪ 978 1 84603 388 9


BRITISH BATTLESHIPS 1939–45 (2)
Nelson and *King George V* Classes

NVG 160 ▪ 978 1 84603 389 6


US DESTROYERS 1934–45
Pre-war classes

NVG 162 ▪ 978 1 84603 443 5


US DESTROYERS 1942–45
Wartime classes

NVG 165 ▪ 978 1 84603 444 2

VISIT THE OSPREY WEBSITE

Osprey Members area ▪ Ebooks ▪ Information on forthcoming books ▪ Author information ▪ Book extracts and sample pages ▪ Newsletter sign up ▪ Competitions and prizes ▪ Osprey blog

www.ospreypublishing.com

To order any of these titles, or for more information on Osprey Publishing, contact:

North America: uscustomerservice@ospreypublishing.com
UK & Rest of World: customerservice@ospreypublishing.com

NEW VANGUARD • 169

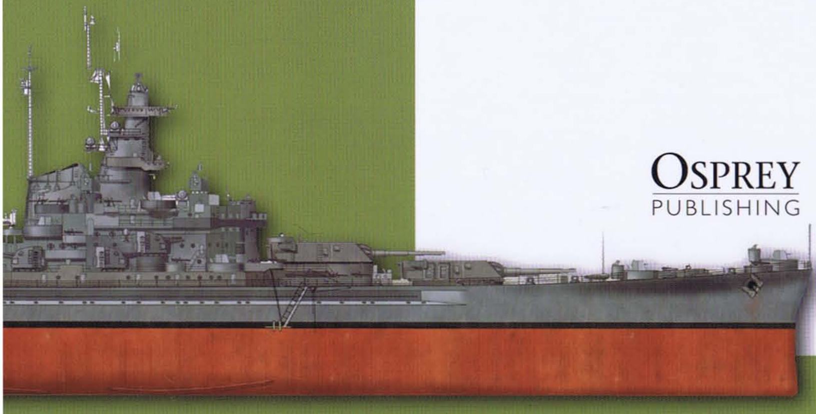
The design, development, operation and history of the machinery of warfare through the ages

US FAST BATTLESHIPS 1936–47

The North Carolina and South Dakota classes

This volume details the design, construction, and operation of the first six of the ten US fast battleships – two of the North Carolina class and four of the South Dakota class. These six battleships were all authorized in 1936 and were the first such vessels built in the US since 1923. Consequently, these ships benefitted from enormous technological leaps, with improvements in ship design, power, armor, armament and the single most important improvement – the use of radar-guided fire control – all combining to help change the course of the war in the Pacific. Packed with first-hand accounts, battle reports and specially created artwork this book tells the story of these war-winning vessels.

Full color artwork ▪ Illustrations ▪ Unrivaled detail ▪ Cutaway artwork



US $17.95 / UK £9.99 / CAN $19.95
ISBN 978-1-84603-510-4

OSPREY
PUBLISHING

WWW.OSPREYPUBLISHIN